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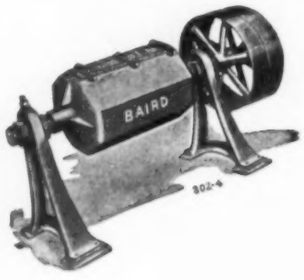
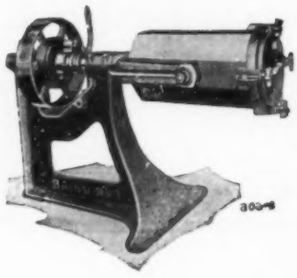
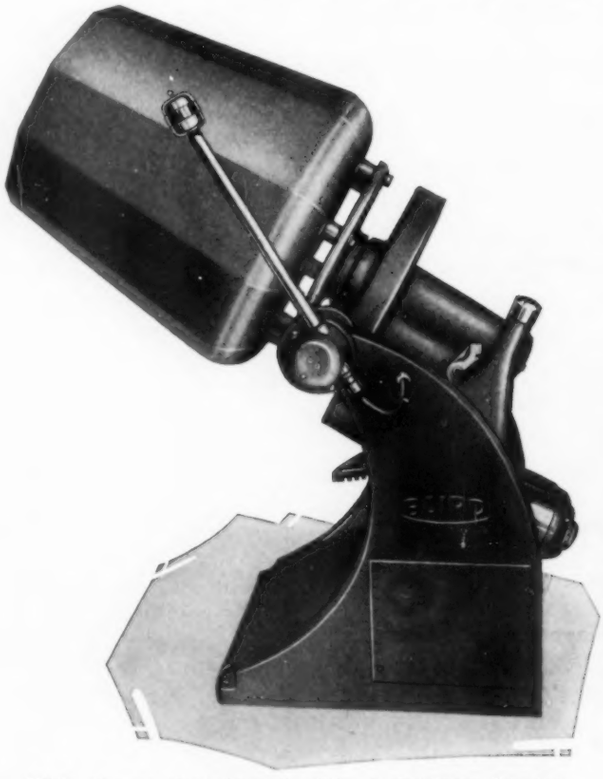




BAIRD TUMBLERS

FOR BARREL ROLLING HAVE BEEN STANDARD FOR 40 YEARS



This shows the side of a No. 1 BAIRD Model B. Single Oblique Tilting Tumbler with a No. 22 Sheet Steel Polygonal Barrel and with an Automatic Electrical Tilting Device.

This picture shows the rear of the machine and the electrical apparatus.

A switch to stop and start the revolving of the barrel is at the end of the lever shown.

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Since 1846 specializing in high production machinery for articles of wire and for ribbon metal. Also machines to turn, bore, etc., castings, forgings, etc., up to 10½" diameter.

METAL INDUSTRY
VOL. 37, NO. 12 FABRICATION · ASSEMBLING · PLATING · FINISHING DECEMBER, 1939

OLIVER J. SIZELOVE

The sudden passing of Oliver J. Sizelove came as a profound shock to his many friends in the plating industry. Complications following an operation severed the thread of life of one who lived a life full of enterprise, service and good-fellowship.

Oliver, as he was called by all who knew him, was always as ready to listen to the advice of others as he was to give it. Lacking the opportunity for a university education, he acquired his technical training largely through self-study and

evening school work, and his proficiencies were admired by even those favored with more formal education.

Oliver was born in Butler County, Ohio, on April 9, 1880, and received his early education in a country school. At the age of 18, after having graduated from high school, he entered into his long association with the electroplating industry by serving his apprenticeship in the polishing and plating departments of the Estate Stove Co., Hamilton, Ohio.

He spent thirteen years in the Middle West as a plater and foreman plater and then went to New Jersey where he was a foreman plater in various companies as well as a partner for two years in a job plating shop.

For twelve years, Oliver was foreman of the large plating and finishing departments of August Goertz Co., Newark and from March 1934 until his passing, he was technical advisor and general sales representative and later secretary of the Frederick Gumm Chemical Co. of Kearny, N. J.

Oliver was an indefatiguable worker who also found time for educational and social work. He was a member of the Newark Branch of the American Electroplaters' Society since 1914 and was awarded the Founder's Gold Medal in 1926 for his paper on analysis of plating solutions. He spent five years studying chemistry at the Newark Technical School and later organized and taught a course on the chemistry of plating.

Mr. Sizelove was, at various times, editorial advisor to the Monthly Review and in 1930, edited the first "Platers' Guidebook" for Metal Industry, and edited three later editions. He was Associate Editor of Metal Industry from 1928 to 1935.

Oliver was Vice-Chairman of the International Fellowship Club in 1937 and Chairman in 1938. He was a Mason and was active in community affairs. He is survived by his wife, his daughter, Mrs. Elizabeth S. Arnold, and two sons, Oliver Jr. and Robert.

At this writing, it is difficult to realize that Oliver is no longer with us. He stood as a symbol of the application of chemistry to electroplating. He will long remain in memory as one of the pioneer educators in electroplating. The industry has, indeed, suffered a great loss and its personnel has lost a true friend.

Greetings

In this last 1939 issue of Metal Industry, the Staff wish to express their appreciation to the readers, authors and advertisers who have contributed much in making this year one of the best which Metal Industry has had since those awful "old" days of the past when business was good and jobs were plentiful and some semblance of peace and reason were extant in the world.

To the people who have cooperated with us and helped guide our destinies we say, "thank you" and to all we say a heartfelt—

Merry Christmas

Co-deposition of Magnesium and Nickel

Some years ago, it was reported in the German technical literature (Koch & Engemann) that magnesium was co-deposited with nickel deposits, and for many years this statement was taken on its face value, with, of course, considerable lack of understanding as to just how this co-deposition could take place.

An American electrochemist, in recent work, has been unable to detect by spectroscopic means, even traces of magnesium in nickel deposits obtained from solutions containing considerable amounts of magnesium salts.

Bulakh has also attempted to verify the findings of Koch & Engemann that magnesium can be detected in nickel deposits obtained from magnesium-containing nickel salts, but was unable to detect magnesium in the deposits. We are led to question the accuracy of Koch & Engemann's findings and it is possible that magnesium may have been trapped in the pores of a porous substrate or that magnesium containing water may have been used in the analysis.

Isotopes

The receipt of "Table Internationale des Isotopes Stables" has brought to our attention, the advances made to date in the isolation and identification of the isotopes of elements.

Years ago it was believed that different atoms of the same element were identical, but certain physical discrepancies led to the belief that perhaps all atoms of any one substance were not the same, and research has shown that although all atoms of the same element contain the same number of electrons in the outer shell or have the same atomic number, differences in the weight of the atomic nucleus occur.

Isotopes are atoms which contain the same number of electrons in the various quantum shells but the nuclei vary noticeably in weight. Thus, for example, hydrogen gas consists of 99.98% hydrogen with a mass number of 1 and 0.02% of hydrogen (deuterium) with a mass number of 2. Nickel contains at least 5 isotopes varying in mass number (relative weight) from 58 to 64, in concentrations ranging from 66% to 1.6%.

The oxide of deuterium or heavy hydrogen has received considerable publicity in the press as "heavy water". It will be noticed that heavy water is not very much heavier than ordinary water inasmuch as only the hydrogen contained therein is twice as heavy as ordinary hydrogen, but the hydrogen constitutes only 20% of the total weight of the water molecule. Physiological and physical chemical properties of heavy water are being studied extensively and it has been found that these properties vary noticeably from those of ordinary water.

During electrolysis of ordinary water, containing 200ths of a per cent of deuterium oxide or heavy water, a greater proportion of ordinary hydrogen is discharged and thus after considerable electrolysis, the relative ratio of heavy water to ordinary water is noticeably increased, and a technique based on this fact is used to isolate water containing considerable quantities of deuterium oxide.

Fire Extinguishers

One of the leading manufacturers of fire extinguishers is presenting, throughout the country, a striking educational demonstration on fire-fighting, using chemical extinguishers.

It is pointed out that although the lack of fire extinguishing equipment itself may be responsible for permitting small fires to spread, a lack of knowledge regarding the equipment used and failure to keep the equipment in proper condition, and in readily accessible places, are contributory causes.

One type of extinguisher is not the best for all types of fires, and manufacturers of equipment should be consulted as to their recommendations for any particular fire hazard.

Polarographic Analysis in the Plating Industry

By Paul Sherrick

Engineer,
E. H. Sargent & Co.,
Chicago, Illinois.

A description of the micro polarograph for the analysis of metal ions is given. Polarographic analysis is essentially an analytical method based on current-voltage curves relying principally upon the dropping mercury cathode to provide a completely polarized electrode in conjunction with one not polarizable. The uses of the polarograph for analyzing plating solutions and determining thickness of coatings by the stripping-analytical method are described.—Ed.

The polarographic method was originated and introduced by J. Heyrovsky and M. Shikata at Charles University, Prague. The original publications issuing in 1922 have been rapidly followed by an extensive bibliography from the laboratory of Professor Heyrovsky and from the widely distributed European and Oriental laboratories of his students. To date, publications covering standardization and application of the method total approximately 460. (See Collection X, No. 2-3, Czechoslovak Chemical Communications.)

Polarographic analysis is essentially an analytical method based on current-voltage curves and relying principally upon the dropping mercury cathode to provide a completely polarized electrode in conjunction with one which is not polarizable.

The application of the dropping mercury cathode has been perfected to a point that, when employed with an adequately specialized measuring system, it offers the following analytically significant characteristics:

1. A completely polarized cathode
2. A non-polarizable anode
3. A high hydrogen overvoltage at the cathode
4. A continuously renewed cathode surface
5. An automatic, continuous resolution of deposited substance
6. A minute cathode area, at which diffusion rate can be established as a current limit.

The primary functions of the micro polarograph are (1) to apply to the electrolytic cell at a predetermined uniform rate an accurately known voltage change and (2) to indicate and record precisely the current flowing through the cell at all stages of voltage increment.

To detect and interpret small current changes, it is essential that the rate of voltage rise be capable of exact duplication and uniform in slope. For this reason, the polarograph employs a constant speed mechanism rotating a precisely calibrated bridge wire wound about a drum.

Obviously, also, to produce complete current voltage records of electrolytes which vary widely in concentrations of the substance being studied, the current detecting system must have a wide range of sensitivities. Furthermore, response characteristics of the detecting instrument must be equivalent in all sensitivities. Thus, an important accomplishment among the component parts of the polarograph is the wide range multiple position constant damping shunt applied to the current detecting galvanometer.

Extensive polarographic experience has also shown that the most accurate interpretation of curves can be made only by measurement and inspection of a graphic record and the micro polarograph, therefore, includes a finely adjusted photographic recording mechanism whereby a curve is automatically traced on a bromide paper sheet which then becomes not only an analytical measure but also an authoritative permanent record.

The precise and convenient provision for the application of an E.M.F. across the electrolytic cell will be evident by reference to Plate I. A rotary insulating drum carries the slide wire resistance "R" and the voltage scale "VS" adjusted to proportionate resistance values of "R." A low resistance sliding contact "VC" applies to the electrolytic cell the fractional part of the total voltage drop across "R" which is determined by the drum position from time to time. The drum is driven by a clockwork mechanism, governor controlled, and adjustable as to speed by means of adjusting screw "S." The clockwork is wound, when the drum is rotated, by means of hand wheel "WV" to the position at which the sliding contact is at zero volts. Rotation begins when the speed adjusting screw "S" is moved away

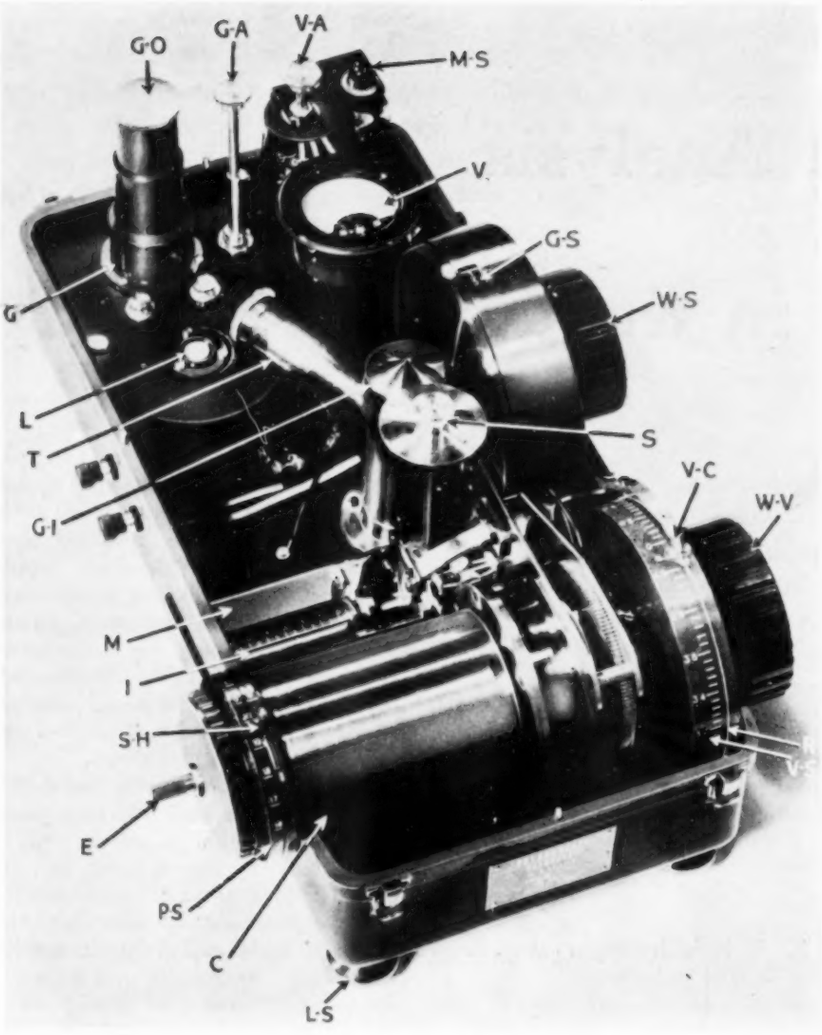


Plate I. Polarograph opened to show various component parts.

from its arresting zero position. The dial of adjusting screw "S" is calibrated to read, 5, 8, 10, 12 or 15, these figures representing minutes per revolution. It will be seen in the illustration that the photographic recording cylinder is mounted on a shaft in common with the potentiometric drum and is, therefore, turned in fixed linear relation with the progressive increase of voltage.

The voltage scale is direct reading when a total E.M.F. of 4 volts is applied to the bridge wire and reads in twice the actual voltage values when the drum is adjusted to a total E.M.F. of two volts. Adjustment of total E.M.F. is made by means of voltage adjusting screw "VA" and read on voltmeter "V." At 4 volts, the polarogram measures 0.187 volts per centimeter.

Master switch "MS" controls application of voltage to the bridge.

The resting position of sliding contact "VC" represents open circuit.

Galvanometer "G," Plate I, is a suspension type of instrument of high sensitivity whose resistance and damping constants are specifically suited to conditions encountered in polarographic work. It is rigidly mounted in the metal case and reflects on the graduated slit "I" the image of a vertical filament in the galvanometer illuminator "GI." The illuminating telescope "T" is stopped at a fixed angle but is equipped with a sliding focusing sleeve. Level "L" is used to adjust the instrument to a horizontal position by means of levelling screws "LS" before releasing the galvanometer, by means of arrest screw "GA."

The filament image is brought to the zero point of the graduated scale "I" by means of the galvanometer zero adjuster, "GO." Mirror "M" allows the operator to observe the progress of the curve through the transparent cover of the instrument case.

The effective sensitivity in current response is regulated by constant damping multi-ratio shunt "GS," positions being selected by rotation of the hand wheel "WS" and the selected positions indicated by fractional figures at the top of the shunt case. The fractions indicated represent the effective sensitivity referred to the full sensitivity of the galvanometer.

Photographic Recording System

The recording system consists of an outer light shielding cylinder "C" with graduated slit "I" in which a second smaller cylinder rotates carrying the photographic bromide paper. The entire assembly is drawn off the shaft after loosening expanding bolt "E," after which the inner cylinder may be drawn from the outer cylinder for loading or unloading. The slit "I" is opened or closed by means of shutter knob "SH."

The number scale "PS" is used to fix the correct starting position for the record by adjusting the zeros of the two cylinders to coincidence after winding. It also serves as a guide to displace the abscissa of a second curve run on a previously exposed chart. Plate II illustrates the outer cylinder partially removed from the shaft and the inner cylinder extracted with the record paper wrapped about the drum and held in place at its overlapping ends by a lever with snap catch. Loading and unloading, is of course, done in a dark room

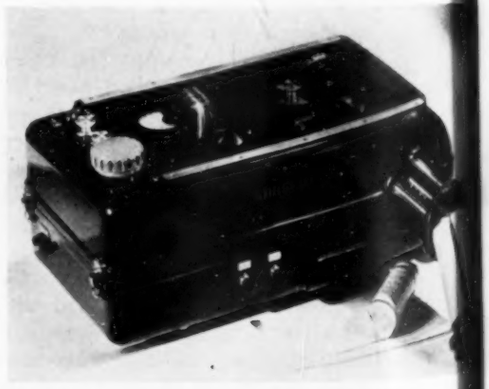


Plate II. Outer cylinder partially removed from the shaft.

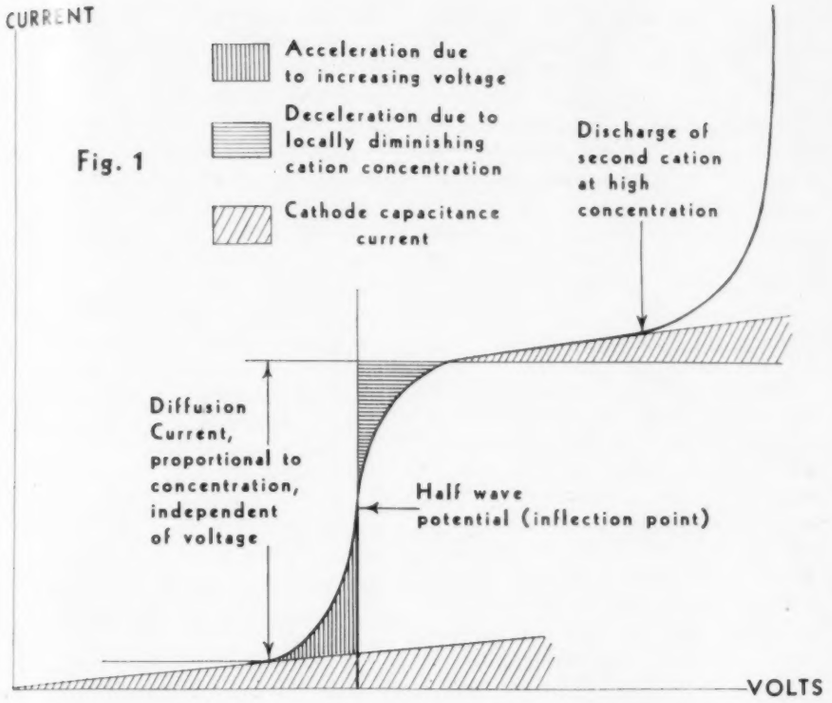

CURRENT
Fig. 1
Acceleration due to increasing voltage
Deceleration due to locally diminishing cation concentration
Cathode capacitance current
Discharge of second cation at high concentration
Diffusion Current, proportional to concentration, independent of voltage
Half wave potential (inflection point)
VOLTS

Fig. 1. Diagrammatic form of record produced by micro polarograph in analysis of reducible ions.

with a ruby lamp and the bromide paper developed in the usual way by a rapid developer, followed by a fixing bath.

Permanent, Graphic Records of Analysis

An analytical record produced by the micro polarograph in the analysis of reducible ions is shown in a diagrammatic form in Figure 1, representing the determination of one cation only in a solution containing an excess of a second indifferent cation. The polarogram is two dimensional with applied voltage measured along the abscissa and current or linear galvanometer deflection measured along the ordinate. The first section of the curve showing only cathode capacitance current is slightly rising in rough proportionality with applied voltage. The current here represented is principally that necessary to maintain the cathode charge on the dropping electrode. This section indicates the absence in the electrolyte of reducible ions whose reduction voltages lie within the voltage range of the section. When a point has been reached equal to the reduction potential of the available ion a rapid acceleration of current begins which, in turn, leads to a deceleration ending in a slope roughly corresponding with that of the initial section. The zone of rapid current change represents the discharge of the reducible ions present in the immediate environment of the cathode. The roughly horizontal section following the rise defines a current whose magnitude is determined by the diffusion rate of the reducible ion into the cathode region, this diffusion rate being practically independent of applied voltage. The final section of the polarogram is a sweeping rise which at most working sensitivities would carry the record off the polarogram, representing the discharge of a cation in large concentration, its identity being determined by the indifferent electrolyte in use. The characteristic form of that part of a polarogram which shows the identity and concentration of the discharging ion is called a current step.

Identity of Substance Established By Voltage Factor Alone

The position with respect to the voltage axis at which the sharp acceleration takes place, indicates the reduction potential of that ion under the conditions existing in the electrolyte and with respect to the mercury cathode. The form of the initial phase of current acceleration and the exact relation of this phase to the voltage axis is dependent upon concentration of the discharging ion in accordance with the Nernst formula. Similarly, the shape of the decelerating phase which follows the inflection point is dependent upon the discharging ion concentration. However, the inflection point of the curve is independent of concentration of the discharging ion and is practically determined as a point corresponding with ½ the current increment produced by the reduction of the ion so identified. This voltage, called the half wave potential, is a characteristic constant for each ion, independent of the concentration of that ion. Figure 2 illustrates the common method known as the "inter-section point method" for the exact determination of half wave potentials.

Height of Step Direct Measure of Concentration

Under proper operating conditions, the height of the step is proportional

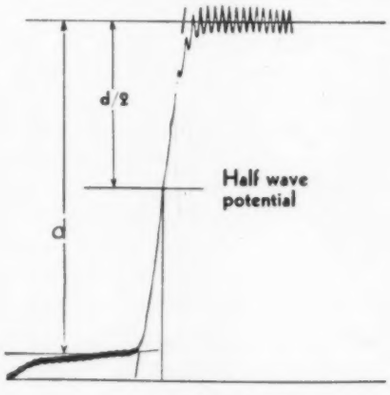


Fig. 2

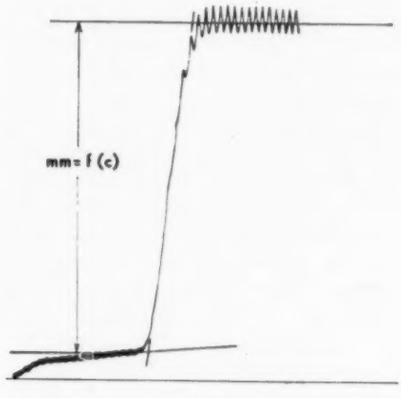


Fig. 3

Methods for determining half wave potentials.

to the existing concentration of the substance yielding the discharging ion. Many different methods are used for measuring this height, the important rule being, however, that comparative curves must be measured by the same method. Most generally applicable is the intersection point method illustrated in Figure 3.

Curve Limits

The useful working range of a polarogram is extended to a high value of cathode potential by employing as the indifferent cations of the solution, the alkali metal ions whose reduction potentials lie in the range of —2.0 to —2.2 volts. The curve is terminated for analytical purposes when the region is approached at which this cation begins to discharge. Since this component is usually held to fairly large concentration, the final stage of the polarographic curve is a steep rise whose maximum height is not within the range of normal sensitivity ratios. This working range provides for prior determination of practically all metals with the exception of the alkaline earth metals and the alkali metals themselves. For the determination of these latter there is substituted as the indifferent electrolyte an organic base supplying either tetramethyl ammonium or tetraethyl ammonium ion, whose reduction potentials are still higher and which extend the range to the vicinity of —2.6 volts. By this expedient even the alkaline earth and the alkali metals themselves may be reduced with analytically satisfactory current steps.

The height of a current step which begins as a function of the local concentration of a discharging ion is limited by the rate at which this ion is supplied to the electrode by diffusion and migration. Obviously, the diffusion rate of dissolved substances not electrically charged is substantially independent of applied voltage and practically proportional to the concentration of that substance existing in the solution. Electrically charged ions, however, migrate with a velocity in part dependent upon any electrostatic field existing between the electrodes. The current limit, therefore, is independent of the ionization constant of the compound supplying the reducible ion only when, by the addition of an indifferent electrolyte in excess, the IR drop across the solution has been reduced to a negligible value, so minimizing the electrostatic field strength. Under such conditions the height of the current step, being almost exclusively determined by diffusion rate, may be easily standardized as a direct measure of concentration in terms of normality.

Solution Composition

Correct solution composition is a requirement both for the successful formation and for the quantitative validity of a current step in a polarogram. The solution must be such that the substance to be determined is held in a definite ionic or molecular form in solution; that the current step for this substance is not obscured by other reduction or precipitation reactions occurring simultaneously; and that curves or maxima due to adsorption, catalysis, hydrogen discharge or oxygen reduction are absent from the region being recorded, or do not obscure the desired steps.

The total concentration of the indifferent electrolyte, estimated as existing after the test sample is added, should be not less than 0.1 N and roughly similar in comparative analyses. In a routine way, this is accomplished by preparation of stock solutions, standard or unknown samples being added volumetrically to definite volumes of stock solutions. In most cases, variations in concenration of the indifferent electrolyte in ratios not exceeding 1 to 2 are negligible in effect upon the heights of the current steps produced.

Sensitivity

The limit for qualitative detection and identification in polarographic analysis is in the order of magnitude 0.01 gamma of mass, or one hundred millionth of a gram. For quantitative measurement, the maximum convenient dilution is about 10^{-5} to 10^{-6} N.

Accuracy

When produced under comparable conditions as outlined in preceding sections, repeated polarograms duplicate one another with extreme precision, even when working at the highest sensitivities in quantitative measurement of the minute concentrations referred to in the common analytical procedures as "traces." The reproducibility and inherent accuracy of the method thus exceeds the ability of the operator to interpret a record in terms of concentration by linear measurement. Obviously the relative error incurred in the linear measurement of step height in a polarogram is smaller the greater that height is made, and hence it is desirable to employ the greatest sensitivity possible. Under average conditions the measurement error is approximately 1 mm or applied to average step height, approximately 1 to 2% of the quantity measured.

Technique of the Dropping Mercury Cathode and Cell

A successful dropping cathode requires (1) a capillary delivery tube of fine bore and properly related length, (2) complete dryness and cleanliness of the capillary bore and (3) very pure mercury. Bore and length specifications of capillaries are initially determined either by the use of standard tubing supplied with the micro polarograph or by the preparation of capillaries with suitable dimensions.

Cell Assembly

The usual electrolytic cell, see Plate III, consists of a mercury reservoir, a connection tube between the reservoir and the dropping capillary, a glass vessel with a mouth to receive a stopper holding the capillary, and with a sealed in platinum contact near the bottom connecting between the anodic mercury mass and the separate mercury containing tube for electrical contact. Some vessels are equipped with side arms for sample addition or gas ejection and with an inlet tube for introduction of bubbling hydrogen or nitrogen gas.

Uses of Polarograph

Polarographic analysis in the plating industry is applicable to two principal purposes, the first being to determine rapidly the concentration of the principal plating metal in solution and the second, for the detection and measurement of small

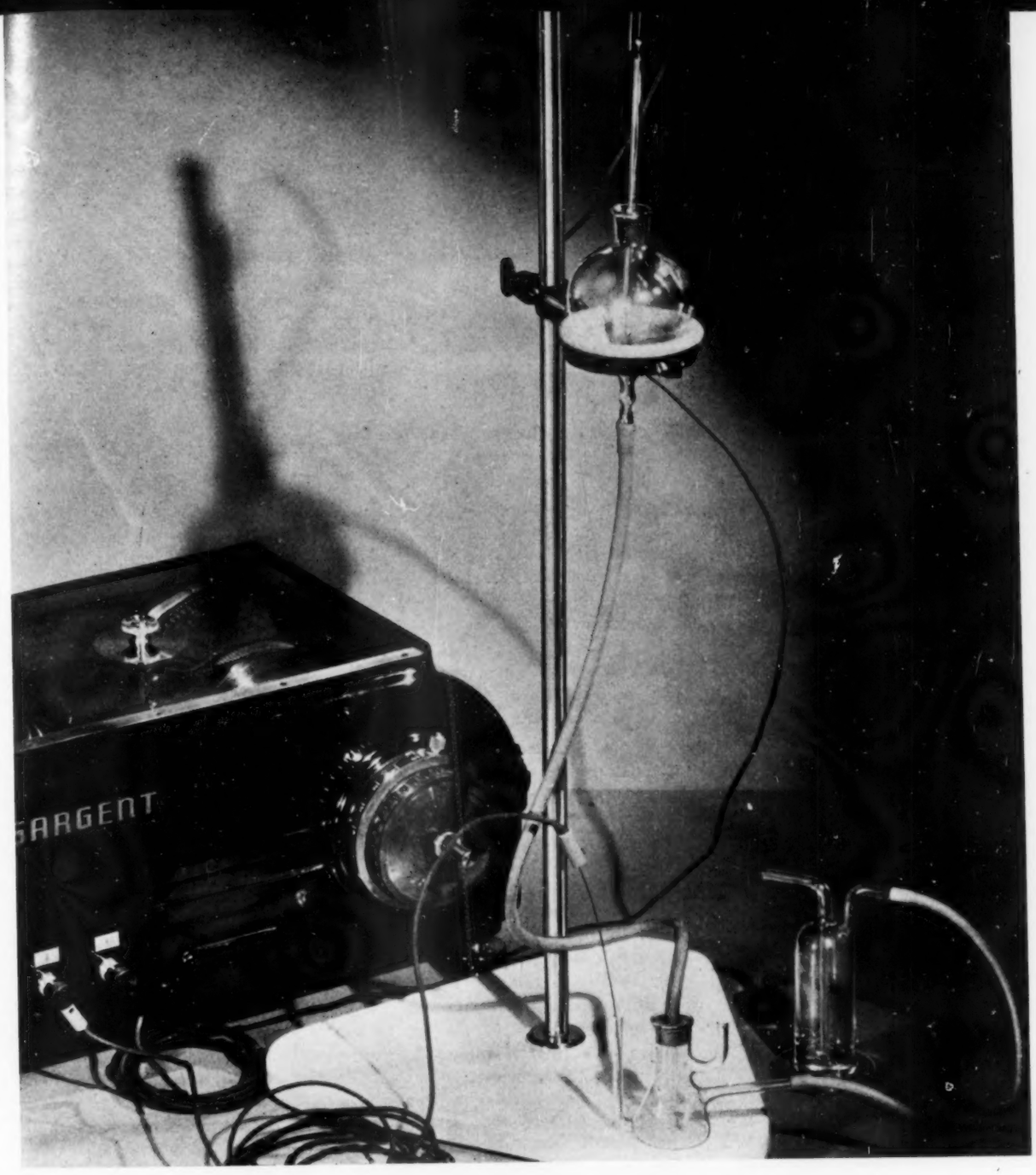


Plate III. Electrolytic cell and recording polarograph.

quantities of foreign metals such as lead, zinc, etc. A third use occurs in the determination of thickness of plating by the stripping procedure. The total quantity stripped from a definite area can be measured directly by a polarogram conducted under conditions described in a later paragraph.

Polarographic measurement of the principal metal in a plating solution is a relatively simple procedure to plan inasmuch as the presence of other metal reduction steps in the polarogram are insignificant in comparison with the magnitude of the principal plating metal itself. The procedure requires an initial quantitative dilution of the sample taken from the bath, since a satisfactory polarogram can be run for substances in concentrations not appreciably greater than 10^{-3} N. The second principal precaution to be taken is that of insuring the presence of a concentration of alkali or alkaline earth metal ions in a normality at least 10 times the normality of the metal ion to be measured. The usual polarographic determination of the principal metal would therefore entail pipetting of a small sample from the plating bath into a 1 liter volumetric flask, adding an approximately measured quantity of properly selected alkali or alkaline earth metal salt, making up to a 1 liter volume, recording of a polarogram with a small fraction of the total solution measured into the electrolysis cell and recording of a second polarogram after the addition of a known volume of the standard solution of the metal concerned and, finally, calculation of the original concentration by ratio of step heights of the polarograms. With reasonable efficiency the entire routine can be conducted in a period of 15 to 30 minutes. Metals so determinable in their respective plating solution compositions include cadmium, nickel, copper, zinc, tin, iron and chromium.

For the polarographic determina-

tion of small quantities of foreign metals in plating solutions each problem requires its own solution as to practicability and procedure. Whenever the "trace" metal can be shown in the polarogram at a reduction potential of at least 0.2 to 0.4 volts more positive than the principal metal, a satisfactory direct procedure can be laid down. In case of coincidence of the reduction voltages of the two metals, it is frequently possible to change the composition of the sample in such a way as to shift the reduction potential of the principal metal to a more negative value and so clear the step of the trace metal. If this fails or if, under all ordinary conditions, the principal metal reduces at a more positive value than the trace metal, the necessity of a chemical separation is indicated and the value of the polarographic procedure in such a case becomes questionable. A typical questionable case of this type occurs in the determination of zinc in nickel plating solutions. The reduction potentials of these two metals are very similar and this laboratory expects in the near future to determine the possibility of suppressing the nickel reduction in order to allow a direct polarogram of the zinc wave. The practicability of this determination cannot be predicted on the basis of present evidence. On the other hand, a polarogram may be made directly on a cadmium plating solution to measure small amounts or traces of copper, antimony and lead, all three being determined simultaneously on one record in the absence of tin whereas if tin is also present, the third step would represent combined tin and lead.

In general it can be assumed, subject to experimental confirmation, that small amounts or traces of any metal in the following table in the presence of any other metal in large excess can be determined by direct polarogram run on the original or slightly modified solution if the reduction voltage of the former is at least several tenths of a volt less negative than that of the latter.

Reduction Voltages for Acid Solutions

(Half Wave Potentials)

Antimony, trivalent	—0.21
Bismuth, trivalent	0.0
Cadmium, divalent	—0.63
Chromium, divalent	—1.42
Cobalt, divalent	—1.23
Copper, divalent	+0.09
Iron, trivalent	+0.1
Iron, divalent	—1.33
Lead, divalent	—0.46
Manganese, divalent	—1.53
Nickel, divalent	—1.09
Tin, divalent	—0.47
Zinc, divalent	—1.06
Titanium, tetravalent	—0.8

Reduction Voltages for Alkaline Solutions

(Half Wave Potentials)

Antimony, trivalent	—1.8
Bismuth, trivalent	—0.35
Cadmium, divalent	—0.80
Cobalt, divalent	—1.44
Copper, divalent	—0.14
Iron, divalent	—1.56
Iron, trivalent	—1.9
Lead, divalent	—0.81
Tin, divalent	—1.18
Zinc, divalent	—1.41

In the measurement of thickness of coatings by the chemical procedure, polarographic measurement of the quantity of principal metals stripped is very economical of time. The solution of metal resulting from chemical stripping procedures yields a large concentration of the plating metal in the presence of small concentrations of other metals dissolved from the base material. Under these conditions, direct polarograms produce quantitative steps for the principal plating metal without interference from the much smaller quantities of other metals present even though the latter reduce at potentials more positive than that of the principal step to be measured. In the case of nickel coatings on brass or zinc base metals, difficulty due to the coincidence of the zinc and nickel reduction potentials is readily obviated by adjustment of the solution strippings to a pH in the approximate value 8.5 with the addition of ammonium acetate. Under these conditions, the zinc step is displaced to a more negative value allowing the nickel wave to be completed before the reduction of the zinc begins. In the case of nickel coating stripped from steel, the direct acid solution without pH adjustment is satisfactory since no coincidence of reduction potentials exists between nickel and iron and since the quantity of iron is small in comparison with the quantity of zinc present.

No interference problems need be anticipated in the case of copper strippings from steel or zinc or chromium strippings from nickel, copper, brass, steel or zinc base die castings. For strippings of zinc or cadmium employing antimony trichloride reagent, it is to be noted that the reduction step for antimony will occur prior to that for zinc or for cadmium. In such a case, it is only necessary to insure that the amount of zinc or cadmium dissolved is in an order of magnitude equal to or greater than the actual amount of antimony present in the stripping solution. Under such circumstances the ratio of the heights of the steps for the reduction of the antimony and of the zinc or cadmium will be such that both steps can be successively completed in a single polarogram in a size sufficient for satisfactory measurement.

For a valid appraisal of the net worth of polarographic analysis in the plating industry it is necessary to consider (1) that polarographic procedures cannot displace all other necessary analytical methods but that they can handle a large portion of present analyses with a distinct saving in operating time; (2) that the change over from present routines to polarographic short cuts requires considerable time and experimentation on the part of an individual well trained in the principles of analytical chemistry, on whom rests the responsibility for establishing the most economical manipulative routines and for teaching these routines to the intended operators; (3) that the original cost of instrumentation and experimental time is substantial and can be radically minimized only with the resultant danger of curtailing the potential usefulness and consequent operating economy of the method. Polarographic installations cannot be successfully made in the absence of a permanent chemical laboratory operated by a professionally trained chemist. (4) Assuming that an adequate investment can be made the speed and directness of polarographic procedures offer attractive possibilities for improvement of plating processes due to elimination of errors in hasty volumetric and gravimetric routines and to the greater volume of chemical control data securable without excessive overhead for additional personnel.

Drum being built up by spraying with metal coating.

Salvaging of Equipment by Metal Spraying

By John E. Hubel

Nashotah, Wisconsin

A description is given of the metal spraying equipment of the Metal Spraying Corporation, Milwaukee, Wisconsin. The process is used for salvaging of undersize parts of all dimensions and for the coating in situ of large objects.—Ed.

As you enter the plant of the Metal Spraying Corporation, Milwaukee, the first thing that impresses you is the sand blasting room, a special all-steel room erected in one corner of the plant. In more ways than one it is not an ordinary sand blast outfit. It is larger than sand blast rooms used by foundries, and it is not used for regular sand blasting of castings, to take off the sand that adheres to castings as they come from the mould. And the abrasive used is not the same as employed in foundries. To remove oxides and scale and to roughen the surfaces in order to provide "key-fasts" prior to spraying the castings or machined parts with metal, angular steel grit is blasted over the entire part, or only over that part which is to be sprayed with metal or coated.

Blast Cleaning

The blasting room is larger than is usually found in foundries or metal treating establishments. It measures about 8′ x 8′ x 15′. The novel features include a steel screen floor, as shown, which permits the blasting abrasive to drop into a hopper beneath the floor, from which it is carried back to a bucket-type elevator by means of a screw conveyor, which raises the abrasive to a reservoir at the top. Also, it has an air renewing system, so that the operator in the closed room can work for a considerable length of time without discomfort or injury to his health, the air in the room being changed six times per minute.

Interior of new sand blast room.

As mentioned above, the only purpose of the sand blasting is to produce a roughened surface on the casting for bond. Sometimes shafts are threadcut or tool roughened and then sand blasted with the special angular sand or steel grit, immediately prior to spraying.

Use for Metal Spraying

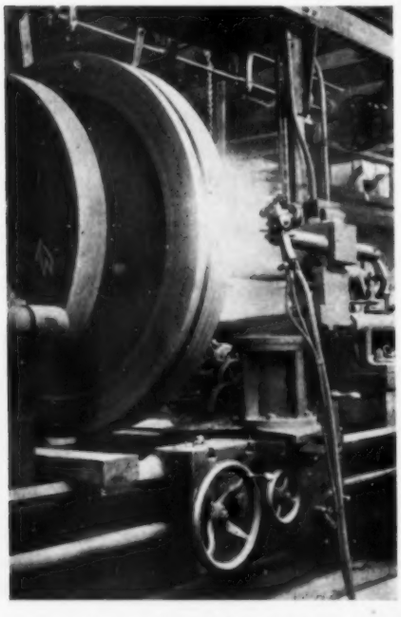
As is well known, the principal object in spraying is the reclamation of worn parts, as spraying oversize and remachining to proper diameter is done at only a fraction of the cost of a new part. To indicate the savings effected by spraying, a lot of about 800 bolts had been brought in by a machinery manufacturer, these to be sprayed oversize so that they could be remachined to the desired diameter, the lot having been machined undersize through error. These bolts were about ¾″ in diameter and 8″ in length. Rather small in appearance, but the machine builder whose machinist had made a mistake in finishing the bolts, found it economical to have all of the bolts sprayed with the proper metal mixture so that they could be remachined to proper size.

From these small bolts, the parts to be sprayed range to worn hydrau-

lic rams and hoisting drums, replacement of which from the casting up would be an expensive procedure. When such parts of machines are sprayed, the metal used for spraying may consist of cold rolled, Norway or low carbon steel if the part is to be used for abrasion resistance only. Or, if a very hard surface is necessary, high carbon steel is applied, which must be emery ground to size after spraying.

If corrosion resisting metals are required, any kind of stainless steel, Monel, bronze or brass alloys may be sprayed on. Longer life and lower maintenance costs result from spraying tanks and receptacles, gas holders, bridges, pipes and chambers with zinc, lead, tin, aluminum or other metals.

A cast iron hydraulic ram being sprayed with high carbon steel.



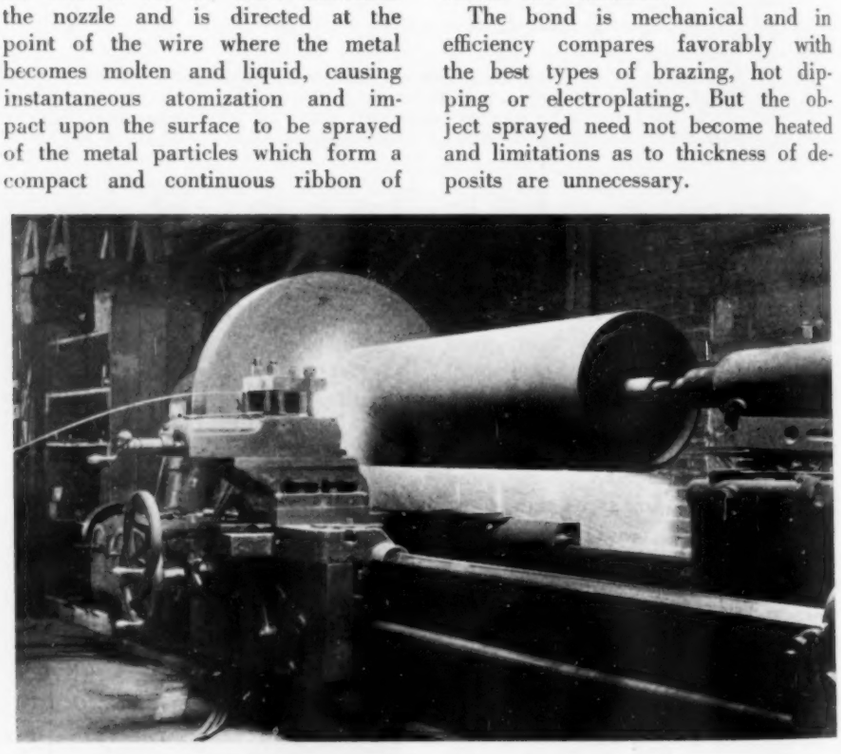
Large piston of a lake steamer being sprayed to regain original diameter.

With the method employed by this firm, there is no limit to the thickness of the sprayed deposit of metal except the economy to be realized. Any metal may be sprayed that is available in commercial sizes of wire. This process is not new, but has recently been developed rapidly because of improvements in the devices for spraying and the method of bonding, and is finding an important place in industry.

Technique of Spraying

Multiple oxy-acetylene flames are used to melt the metal in wire form which is fed into the center of the flames by the power supplied by an air turbine. An air blast surrounds the nozzle and is directed at the point of the wire where the metal becomes molten and liquid, causing instantaneous atomization and impact upon the surface to be sprayed of the metal particles which form a compact and continuous ribbon of metal. Successive coats may be applied immediately and bonded fully to form the thickness desired. Sprayed molten metal deposits are impervious for many practical purposes, will not peel or spall, may be machined, filed, ground or worked similar to the original metals, and also react similarly in resisting corrosion and abrasion.

The bond is mechanical and in efficiency compares favorably with the best types of brazing, hot dipping or electroplating. But the object sprayed need not become heated and limitations as to thickness of deposits are unnecessary.



Giant printing cylinder being metal sprayed.

It is also possible to coat, by spraying, wood, plaster, concrete or compositions, and the surface need only be reasonably clean and free from oil and water.

The characteristics of the process

(*Concluded on page* 576)

Hot-Dip Tinning

of Milk Cans and Ice Cream Cans

By Wallace G. Imhoff

President,
Wallace G. Imhoff Co.,
Vineland, N. J.

Mr. Imhoff, who is a consultant on hot-tinning and hot-galvanizing, has written a detailed account of the methods employed in hot-tinning milk cans. Pickling, fluxing, tinning and subsequent finishing operations are described in detail. This article is the first of a series by Mr. Imhoff on American hot-dip tinning practice.—Ed.

As might be supposed, no two plants use exactly the same materials, the same equipment, and the same practical methods in hot-dip tinning and retinning milk cans and ice cream cans. The purpose therefore at this time is to furnish information of a technical nature that will be of value, and can be used in most any plant, anywhere.

Material for Cans

There are many different sizes and shapes and designs of milk cans, and in addition some cans are heavy cans and some are light cans. Heavy milk cans have a 16 gauge breast and an 18 gauge body. The steel has three cold rolls, has been pickled, and limed. The light milk can has an 18 gauge breast and a 22 gauge body. The body, like the heavy can, is made of hard cylinder stock. The 32 quart can has a 16 gauge breast and an 18 gauge body. The 5 gallon can has an 18 gauge breast and a 20-22 gauge body. The steel is cold rolled, pickled, and limed. The steel is obtained from large steel corporations and is known as cylinder stock.

About 10% of the troubles encountered in hot-dip tinning of milk cans and ice cream cans may be attributed to the quality of the steel. It is therefore very important to see that clean, sound steel is used.

It can readily be appreciated that there are three very important components to good tin coatings. These are the quality of the base metal, the quality of the tin used, and the skill, or technique in putting the molten tin on the steel. If one of the three is defective, it will make all three defective.

Wallace G. Imhoff

Raw Materials

Before discussing the actual hot-dip tinning operations for tin coating milk cans and ice cream cans, a few words should be said about the raw materials used in the process, and the equipment necessary to do the work. The raw materials consist of metallic tin, fluxing materials such as sal-ammoniac, white powdered sal-ammoniac, zinc ammonium chloride, zinc chloride, commercial cleaners, acids, glycerin, tinning greases, inhibitors, sawdust, whiting or plaster of Paris, clean rags, fuel oil, and sometimes tallow or palm oil, and paraffin distillate. Only a brief word can be said about these materials at this time.

The tin should be a very soft grade of *high quality* STRAITS TIN. Some of the other tins contain chemical elements that make the tin hard and brittle, and such tin often gives endless coating troubles. A few of the important facts about tin which should be known are as follows: it melts at 232° C. (449° F.); cast tin has a specific gravity of 7.28; liquid tin at the melting point 6.98. Purest standard cast tin has a Brinell hardness of 5.4. It has a specific heat of 0.0585, and a latent heat of fusion of 14.4 gram calories per gram. It weighs 455 lbs. per cubic foot; 0.263 lbs. per cu. in., and in the liquid tin bath weighs 436 lbs. per cubic foot. The impurities found in tin are antimony, lead, bismuth, copper, iron, and arsenic. Iron and antimony tend to make tin hard and brittle. At a temperature of 530° F., tin takes on a yellow color due to oxidation.

Before the work can be properly processed, it must be put through a good commercial cleaning bath. In pickling, both sulphuric and muriatic acids are used. A good inhibitor should of course be used in the pickling bath. After pickling, the work is fluxed and then put into the molten tin. Various kinds of fluxes are used in different plants. Some plants prefer a liquid flux of zinc-ammonium chloride after the work

has been thoroughly washed after pickling, then on into a slag flux on the tin bath of the usual coarse or medium gray sal-ammoniac. Others use simply a zinc chloride dip with some white powdered sal-ammoniac in it. The sal-ammoniac flux on the tin bath is conditioned by the use of a very small amount of commercial glycerin.

One of the most vital factors of good tin coating by the hot-dip method is to always use a very high quality grease. A poor, low quality grease while perhaps having a low cost purchase price, is in reality exceedingly expensive in the end. Only the very highest quality prime tallows should be used. Paraffin distillate is sometimes used to remove the grease; some plants give the work a last dip in a water bath with a very high grade fuel oil on it. Cedar sawdust, powdered lime, pine sawdust, and very clean soft rags are used for wiping and cleaning the work. Alcohol and whiting, or gasoline and whiting are used to give it a beautiful clear shiny lustre before it is wrapped in heavy brown wrapping paper for storage.

Equipment for Tinning

The materials having been briefly discussed, the next feature of importance to examine is the equipment used. This varies very widely from plant to plant depending upon the scale hot-dip tinning is done. Small companies naturally do not have the elaborate equipment used in larger companies. Therefore to cover the equipment, a brief description of that found in some of the larger companies will be given, and remarks will be made from time to time qualifying it for the smaller companies.

In the larger companies, both the hot-dip tinning of new milk cans and ice cream cans, and the retinning of old cans are carried on with the same equipment. There are really two departments, a rough tinning department, and a finishing tinning department. The equipment in the rough tinning department consists essentially of two tin pots, cleaning solutions, and pickling solutions. The one tin pot is used as a dross treating tin pot, and also for remelting out the solder, etc. in taking old cans apart to be retinned. The second tin pot is a black tin pot, or a rough tin pot, in which the tin is of not very high quality, but is still good enough to put on the first rough tin coat.

Old cans usually have butter fats, etc. in the seams, and therefore before the cans are processed at all they must first be put through a cleaning solution. After this, they are rinsed clean, and then taken apart in the dross tin pot. The cans are tinned and retinned with no bottoms in them to speed up production, and give a higher quality product.

The rough tinning furnace is the usual type of furnace and may be heated with either coal, gas, or oil as a fuel. The tin pots are cast iron pots 30″ x 30″ x 24″ x 1¼″. The furnace is of brick with the usual angle iron bracing and tie-rods, and the design is of the Dutch oven type with the products of combustion passing around the pots and joining a common stack at the rear. The top of the furnace is covered with a 3/16″ steel plate. There is a pyrometer showing the temperature of both pots at all times.

The rough tinning department serves two purposes, namely for reclaiming the by-products of tinning, and for taking old cans apart that are to be retinned. It is also used for retinning in the rough tin pot, hoops and those parts which have to have a first tin coat before going to the retinning department. The tin and lead pot has 1 to 2 inches of tallow on it, and is carried at a temperature of from 500° to 600° F. The work consists of two main divisions, the black stock to be rough tinned, and the work that has come in to be retinned, old cans that must be taken apart, and the pieces tinned separately.

All cans have to be thoroughly degreased before attempting to pickle them or rough tin them. This operation is carried out in the can washer, or degreasing machine. All articles having any grease, or milk or cream deposits in the seams must be first degreased. The cans sent in to be retinned are then taken apart in the rough tin pot. Then the parts and the black steel parts are both pickled. The black steel parts such as breasts and other parts are pickled in sulphuric acid pickle while the tinned parts are pickled in the muriatic acid pickle. Both kinds of parts must be thoroughly pickled. All rust must be absolutely removed. After pickling, the parts are thoroughly washed, then given an alkali dip, and placed on a dryer. They are then given a very light acid dip and placed in the rough tin bath for the rough tin coat.

If gas or oil are available for fuel, the fires can be more closely controlled than with coke or coal. Hoops are tinned with a mixture of 75 parts tin and 25 parts lead, and the solder for the bottoms is 54 parts tin and 46 parts lead.

To appreciate the problems of tinning and retinning, it is necessary to again call attention to the steel base. There are four kinds of steel: that with a clean hard surface; that with light rust on it; that with heavy rust on it; and that with alkali on it. It can be seen at once that the condition of the surface upon which the tin is deposited is of prime importance. It is impossible to get a smooth tin coating on a rough surface. These facts should be kept in mind.

Tinning Operations

Pickling

The tinning and retinning operations are divided into two main steps —pickling and tinning. The pickling tanks may be of wood, or of acid-proof brick. Each pickle tank should be large enough to hold about sixteen cans, of the forty quart size. The pickling acid used for this type of work is muriatic acid. One of the reasons for using muriatic acid instead of sulphuric acid is because it gives a higher quality product.

It is better to heat the pickling tanks with enclosed coils as this gives more accurate control of the pickling baths, by eliminating all dilution of the pickling solution with water from condensed steam in the lines. It is impossible to standardize pickling operations with a constantly changing acid strength and volume of pickling solution.

The work is all pickled in wooden crates (to avoid damaging the cans) which are lowered into the pickling tanks. The temperature of the pickling bath should vary from 140° to 160° F. If it is necessary to pickle over 160° F. then there are not enough pickling tanks to meet the required production, and more tanks should be installed. It is not good

pickling practice to carry the bath over 160° F. The strength of the acid may vary from 8 to 12 per cent depending upon the rust or the kind of scale to be removed. All the pickling in this department is on high grade first class steel base. The water lines to the pickling tanks should be one inch lines, and steam lines three inches at the main line, and at least 1 to 1¼ inches inside diameter of the steam coils. For a very large production, that is at least 500 to 800 cans a day, the pickling tank size should be at least 10 feet long by 3 feet wide, and 3 feet deep, inside measurements. The number of pickling tanks will depend upon the number of tinning stacks, and the production required. Each hot-dip tinning stack should have at least two pickling tanks and a wash tank. All the tanks should be the standard size of 10 feet by 3 feet by 3 feet to make them interchangeable units. Particular care should be taken to see that all alkali has been removed from the cans when they come to the pickle. In practically all cases, the best method is to take the cans apart, and tin the separate pieces such as hollow bodies in one setup, and then a run of breasts, etc. Production is higher, quality better, and it is easier to make a large run on one item, or part.

The operations in the retinning of 40 quart milk cans are the following—(some tinned with no bottoms in them):

Tinning

After pickling, they are thoroughly washed and passed on into the tinning room. One complete unit in the tinning room consists of a flux tank, a rough tin pot, a soak pot, a finishing tin pot, a drawing pot, a list pot, and an oil quench tank. The articles first going into the flux tank which may be a liquid flux of zinc-ammonium chloride, or as in some cases, simply zinc cloride to which a small amount of white, fine powdered sal-ammoniac has been added. Some companies use a standard commercial tinning flux as purchased in the open market. From the dip in the flux, the articles are passed on to the rough tin pot. There is 6 to 8 inches of a slag sal-ammoniac flux on this rough tin bath to stop any spattering that might occur. The temperature of the rough tin bath is about 560° F. The next step is the rough grease pot which is held at a temperature of 550° F. From here the next step is into the finishing tin bath which is held at a temperature of 480° F. From the finishing tin bath, the next step is into the finishing grease pot which is held at a temperature of 480° F. also. It is then finally listed, (the drip removed) and then put into an oil quench nearby.

When removed from the oil quench, the articles are placed on a short conveyor and passed into the drying, cleaning, and finishing department. This department can be operated by women. The first operation consists in passing the work through a cedar sawdust wet with kerosene oil. This removes the worst of the oil. After being well treated in the cedar sawdust, it is passed on to the whiting compartment where it is shined, and then it is passed to a pine sawdust box where it is treated with very fine soft sawdust, and lastly they are rubbed carefully with very soft rags. By this time, the work now has a beautiful, smooth, bright tin coating finish.

Whole cans are carefully inspected, tested, wrapped in brown wrapping paper and sent to storage. Can parts are carefully shined, inspected and placed on the conveyor where they go to the assembly department to have the bottoms soldered in, the can tested, the surface shined with whiting and gasoline or whiting and alcohol, wrapped, and sent to storage with the others.

Defects in Tinning

There are a number of very important features that must be observed to obtain good high quality tinning. One of these is that all operations must be definitely controlled. The tin baths and the grease pots all must have pyrometers on them clearly showing the bath temperatures at all times. One bad overheating of a tin bath, or grease pot will ruin the contents of the pot. Attention is again called to the fact that only the very highest quality greases and tallows can be used; cheap grades only invite costly trouble, sometimes extremely difficult to locate. The new grease must always be added to the clean grease pot, and when grease is needed for the soak pot it should be obtained by dipping out enough from the clean grease pot. The greases must be kept in good condition.

The pyrometers must be carefully checked from time to time to be sure they are registering accurately. The tin is boiled out twice every night on heavy production. The oil quench tank contains about two-thirds water and one-third oil. The oil is a very high grade furnace oil.

Flaking, or spangling, is often caused by the zinc chloride. When this happens, some tin chloride may be used along with the zinc chloride. Tins containing antimony may also cause this trouble of spangling. Glycerin is used as a flux conditioner on the tin pot. It keeps the flux light and foamy, and the proper consistency is when the boiling flux surface has a shiny, glistening surface like that of a soap bubble. A dry, caky flux will cause flux spots, and give a very inferior, poor finish. Light hoops are tinned at 550° F. for the rough tin pot; 540° F. for the soak pot; and 500° F. for the finishing tin and the finishing grease temperatures.

Reclaiming Tin

About 70% of the good tin in the by-products can be reclaimed by the proper treatment. The tin dross and all matter containing tin are first taken to the rough tinning department and treated in the dross tin pot. The material is worked over and over until the largest part of the good metallic tin has been gotten back into the bath. The dirt still containing some tin is then taken outside and worked over in a small reclaiming furnace which consists of a pan about 6 inches deep set over a coal fire. The pan is set on a slant toward the front of the furnace, and there is a small tap metal drain pipe welded into the front of the pan. The tin dirt is spread out in the pan over a large surface area; the pan is about 4 feet long by 36 inches wide and 6 inches deep and made out of ½ inch steel plate. When the tin ashes are fairly hot, sal-ammoniac is dusted over them and the whole worked carefully with a small hoe. The metal runs down the pan to the front and when enough has accumulated, it is tapped off into pigs. The great care needed

here is to keep from burning or oxidizing the tin in the pan. One man generally does this job as it is too costly to keep men learning and burning up tin at 50 to 60 cents a pound. A small bonus on this job pays well.

Control of Coating

The weight of the tin coating is controlled in a couple of ways. For example, the thinner the flux, the lighter the tin coating, and the thicker the flux, the heavier the tin coating. Heavy articles start at a bath temperature around 550° F. and finish around 480° F. Light articles start at 480° F. and finish at about 550° F. The length of the time in the tin bath, the temperature of the bath, the gage of the steel base, the manipulation by the men on the pots, all directly affect the weight of the tin coating. Overheating of the tin makes a much heavier, dull, brittle coating that will peel and flake off easily. The purer the tin, the lower the bath tempearture and the lighter the tin coating.

The testing department consists of a number of compartments each 15 by 20 by 30 inches. They are made of steel and the solutions are heated with a ½ inch enclosed steam coil. The cans are dried with gasoline and whiting, and then carefully polished with clean soft rags, then wrapped in heavy brown wrapping paper, and finally stored in a nice light, dry warehouse.

General Information

There are naturally many difficulties that appear in so many operations. Pickling is one of the first places to look for trouble. A good inhibitor should be used to keep from burning, or overpickling the steel. Then there is the condition of the flux on the tin baths, also the condition of the greases. The process cannot be hurried as a definite required time must be allowed for each operation. Care is of course not to be forgotten, and the cleanliness of the solutions has already been mentioned. Finally as mentioned many times, the temperature is the most important single item or factor to watch closely, and too much importance cannot be attached to the quality of the tin and other raw materials. It is impossible to obtain a high quality material cheap, or at a reduced price. The quality always suffers when the price is less, and often endless trouble and expense are caused by trying some new cheaper raw material. It is best to stick to the standard high quality raw materials and pay the price for quality materials; generally it is possible to obtain the greatest savings by improved technique, and complete teamwork and harmony among the operators and management.

The following tinning solders have been used very successfully for soldering all kinds of hot-dipped tinned articles such as milk cans, ice cream cans, dairy pails, etc.:

Solder for Milk Cans and Ice Cream Cans

80 to 100	445 lbs. tin	555 lbs. lead
85 to 100	460 lbs. tin	540 lbs. lead
90 to 100	474 lbs. tin	526 lbs. lead

The following precautions should be observed: They have been mentioned in various places before, but are summarized at this time to call attention to the important factors in order that success of tinning may be assured.

1. Use good *Straits tin.*
2. *Use a thermometer or pyrometer on every pot;* do not attempt to either tin, or retin by guessing temperatures.
3. *Use a small hand thermometer* for *knowing* your pickle bath temperatures, and *test your pickling solutions* for *acid strength and iron content.* Empty at 8% iron.
4. *Watch overheating of the tin bath;* a temperature of 600° F. is *too high.* Always work at as low a temperature as possible; the one that gives a light, smooth, bright coating.
5. *Watch that the solutions are not carried from one tank into the next;* contamination is the hidden factor of greatly increased costs.
6. *Tin is expensive;* care and cleanliness are of the utmost importance; *use only a good soft brand of Straits tin.*
7. *Do not guess at anything;* there is equipment available to know the conditions attending every operation.
8. There is *no cheap, easy, short method for good high quality hot-dip tinning.*

Salvaging of Equipment by Metal Spraying

(*Concluded from page* 572)

are unique, and therefore provide a new method of repair, maintenance and manufacture and seldom displaces etsablished methods such as welding, plating or painting. It usually goes beyond customary procedures and opens up entirely new fields of engineering practice. Most of the applications described have been fully proven and are considered good practice by representative firms in national industries.

Among the large jobs that have been sprayed by the Metal Spraying Corporation have been the building up of large pistons for low pressure steam cylinders; steel rolls 6 feet in length; large motor armature shafts, on which only the main bearing sections were sprayed, without distorting the shaft or taking off the armatures while the shaft is being sprayed; large cooking kettles for breweries; tympan cylinder body sprayed with low carbon steel; a propeller shaft for one of the largest steamships on Lake Michigan.

This spraying service is not confined to parts of machines brought to the spraying company's plant, as the same work can be done at the customer's plant or in field locations. While much of the work comes from Milwaukee customers, as that city is noted for its numerous metal working plants and users of large machinery, unsolicited orders are coming from distant points to the Milwaukee firm.

The Metal Spraying Corporation was started about six years ago, having been started during the depression. In fact, the fact that there was a depression was responsible for the bringing of many jobs to this company, as more parts of machines were reclaimed or repaired during that period than would have been considered necessary in good times, in which machines are more frequently replaced by new ones. However, as more and more machinery users learn of the facilities for having worn parts of machines sprayed with metal, frequently of a better grade than originally used, and remachined, this process is resorted to by many who could well afford to replace the worn parts with new ones.

Gas-Fired Galvanizing Equipment

By Fred M. Carlson

President,
American Tinning & Galvanizing Co., Inc., Erie, Pa.

The author describes how economies were effected in his plant by installing ingenious gas kettles for hot galvanizing and by using flue gas heat for after-pickle drying tables.—Ed.

For the job galvanizer who would like to take advantage of modern fuel engineering principles and replace antiquated dip kettle heating systems with ones which achieve better and cheaper zinc melting and maintenance, the following experience will be worth reviewing. This case will be of particular interest to *small* job galvanizers because it demonstrates that the advantages and economies of the new gas-fired, automatic, and modern galvanizing equipment developed for high efficiency usage by large scale galvanizers*, *can be realized in good measure by the local job operator* (even if the volume of work handled does not warrant the purchase of expensive units) if he is willing to roll up his sleeves and "engineer" a new kettle on modern heating principles. By buying good gas burners, controls and refractories, and by doing his own construction and engineering, "big-scale" efficiency can be adapted to simpler needs.

American Tinning and Galvanizing has now operated for two years a 7½-ton capacity welded steel kettle ingeniously positioned in a home-made setting and fired with luminous-flame city gas burners. The following advantages are claimed over the previous coke-fired arrangement:

(1) appreciably lesser fuel costs
(2) longer kettle life
(3) lower dross production
(4) better distribution of heat input and temperature over the outside heated surface of the kettle
(5) much greater convenience of operation
(6) savings in labor for coke firing and ash removal

Fred M. Carlson

(7) the elimination of coke storage
(8) better control of metal temperature
(9) lower temperature in combustion zone to attain same degree of heating, and
(10) the ability to heat up in 30 to 40 minutes as against 3 to 4 hours previously required.

Further, the complete cost of making the installation, including labor, materials, kettle fabrication, burner and control equipment, drying table, and incidentals, did not exceed $1,000. Additional savings were reaped through the elimination of drying tables which had to be separately fired, it being possible to arrange clever convenience-tables heated by the waste flue gases from the galvanizing kettle heating system.

Luminous-Flame Fired for Flexibility and Even Heat

In planning the kettle, American Tinning and Galvanizing had to bear in mind the wide range of operating conditions to which the equipment would be subjected. Among the products regularly galvanized in the shop are: pipe straps, bolts and nuts, hinges, pipe fittings, propane tanks, barrels, traps, miscellaneous sheet metal assemblies, and short structural sections. 8,000 pounds of work a day was average on cast iron fittings, but for other types of work this figure might be halved or doubled.

Therefore, two No. 110-1 North American gas burners, rated at 500,000 B.T.U. per hour each, were installed at one end of the setting (one on either side of the 7-foot kettle) so as to produce a long, luminous flame which could sweep over a central horizontal baffle, down at the other end of the kettle, and back under the baffle to a common flue offtake at the firing end. Being separately supplied with gas and air (the flow of each regulated by pressure

*Generally convection-heated or immersion-tube-heated.

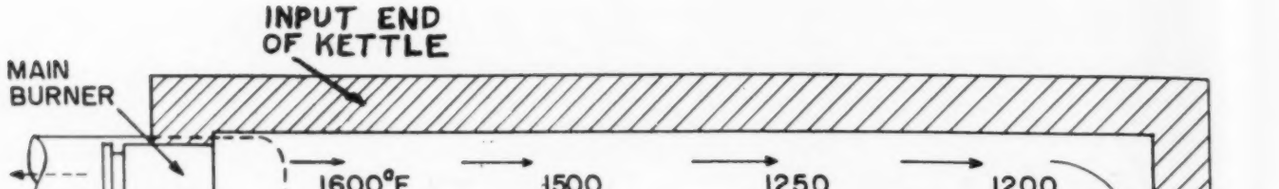


Fig. 1. Schematic vertical section of galvanizing-kettle firing zone (section A-A, Fig. 3), showing actual operating temperatures at eight points and demonstrating the uniform kettle heating obtainable with luminous gas flames.

governors adjustable to any desired level) the burners could be turned down from roaring full rating to a small fraction of full heat input, and the length and luminosity of the flames could be controlled within reasonable limits. For overnight holding, two auxiliary tile gas burners, each capable of any heat input of from 60,000 to 180,000 B.T.U. per hour were set just below and inside of the two main burners.

The main burners were equipped with thermostatic control through a butterfly valve unit in the air line—the air supply being at 16 ounces per square inch pressure and served by a 1½ horsepower blower.

Figure 1, giving actual test readings made through special observation plugs provided along each side of the setting, shows how effectively this firing plan insured constant heat input along the length of the kettle. It also shows the small temperature gradients encountered. Even at the worst point, the firing end, only 650° F. was the top-to-bottom difference observed. The net effect upon kettle life, an important item to galvanizers is obvious.

The significance of the heat distribution, as shown by the temperature readings in (Figure 1), becomes apparent when it is realized that fully 90% of the work goes through the upper half of the zinc bath and that the higher temperatures occur at the top of the input end of the kettle where the greatest heat absorption takes place then diminishes toward the exit end.

Kettle and Setting Design

The kettle itself was, of course, fabricated on order by a steel construction company. Of 1-inch steel plate with a curved bottom of 9-inch radius, it was made 28 inches across the top, 32 inches deep, and 7 feet long. Its welded end-walls were vertical. A flange of 4″ x ¾″ steel bar was welded along each side of the kettle one inch from the top, to form a seal between the firebrick slabs forming the firing chamber roof and the sheet steel top plate (Figure 2). This flange was not designed to carry any of the weight of the kettle and its charge, that job being assigned to the sand bed in which the bottom of the pot was to rest.

Except for the firebrick layers which formed the floor of the whole setting and the floors of the combustion zones, and the firebrick slabs which constituted the central baffles and the roofs of the combustion chambers, all the refractory walls of the setting were made of at least 9 inches of No. 2500 Insulbrick. In the top hot-zone, the width of this insulating firebrick increased to about 14 inches by virtue of the corbling-in arranged to support the firebrick roof. The setting was completely enclosed in a sheet-steel and angle-iron shell, and provided with a concrete slant-walled moat to preserve metal and forestall accident in the event of pot rupture. Excluding the moat the complete setting measured 10′ long by 6′ wide.

Convenience Drying Tables Utilize Flue Gas Heat

With a metal working temperature of 830° F. to 860° F., the flue gas temperature at the outlet of the kettle setting could not, of course, be permitted to drop below 825° F. when any volume of work was being handled. But these flue gases contained heat which the writer, in his quest for efficiency, did not care to lose. For this reason, it was decided to utilize the flue gas heat in special after-pickle drying tables, and thus save more operating dollars and B.T.U.'s. One long table, 14 feet by 7 feet wide, was devised with 10-inch channels for side walls, a sheet-iron bottom supported on angles, and an open top. The inside space was baffled, and the walls insulted with 1½″ asbestos paper pads. Over the open top were fitted two tilting slabs of heavy steel plate, each 6′ x 4′ in size and edged (except at the front) with 4″ angles. These (Figure 3, left) were the drying tops. Here it is worth noting that time can be saved in unloading dried castings

from these tops by simply chain-hoisting the rear edges and letting the charge slide into waiting wheelbarrows or dollies.

The flue gas connections from the kettle setting to the drying tables and from the drying tables to the outside atmosphere are simple and ingenious. The products of combustion leave the kettle setting on the same level as the firing burners in one horizontal 12″ flue pipe. This pipe carries one covered 6″ vertical outlet, opened only at night to vent the holding burner flue products by natural draft. In regular daytime operation, the main burner flue products flow through the 12″ conduit into ducting which fans out to a 36″ by 8″ deep slot in one end of the combination drying table. After traversing the baffles in the drying tables and releasing their heat to evaporate moisture from pickled work, the gases reach the other end of the table, drop down through another slot (40″ by 4″ wide) in the drying table floor, pass into a run of 10″ vertical flue pipe, and descend a foot or two to turn at right angles in an elbow which expands to 12″ diameter and is fitted with an air jet (of 1½″ pipe swaged down to 1″ at the jet end) supplied with 10 ounce air and aimed in the direction of exit. The inspirating effect of this air jet carries the cool flue products horizontally out of the building—the extra exhaust force being required to eliminate the necessity for a stack to supply draft, and to induce further movement of the cool flue gases after their long and tortuous travel to a point below the original level of firing.

Fig. 2. General view of gas-fired kettle and tilting top drying tables heated by kettle flue gases.

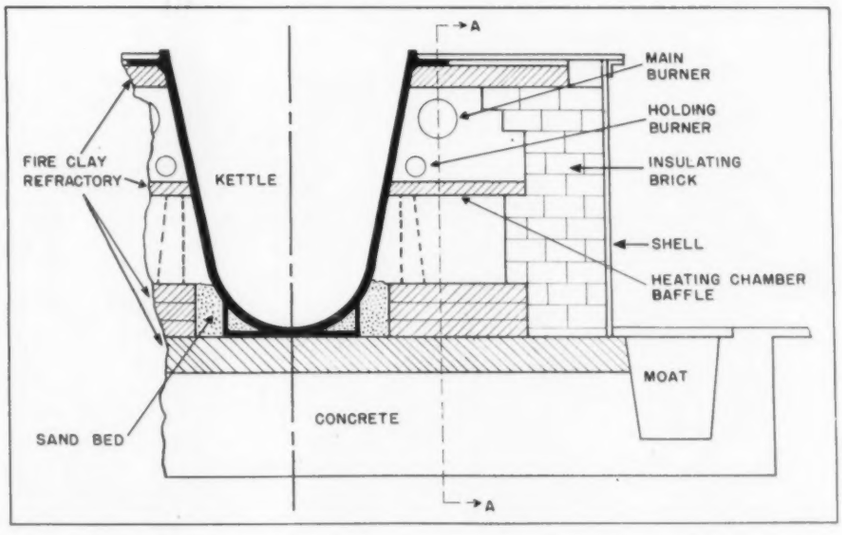


Fig. 3. Vertical section showing construction of kettle-setting.

Actual Cost Studies Prove Savings

Let us look, finally, at the economics of this equipment. An actual weekly test showed that 10,560 cubic feet of 950 B.T.U. per cubic foot mixed natural and coke oven gas was consumed during five normal 8-hour working days. To hold the metal at 700° F. over Saturday, Sunday and the weekday nights, took 17,824 cubic feet of gas. During the week 17½ tons of work were handled. At the prevailing gas rates it figured out that the gas cost only 80 cents per ton of work, including both holding and working gas—and, for small job shops which coat a wide variety of work on highly intermittent schedules, that's a mighty satisfactory figure.* An average month means about 125,000 cubic feet of gas, and the bill is seldom over $70. In a good month, American Tinning and Galvanizing handles 120 tons of work, in a bad one perhaps 70. Per pound of work, the overall gas cost never exceeds 4/100 of one cent.

*A large galvanizer operating continuously on one product per kettle can often achieve fuel costs as low as 15 cents per ton if modern gas equipment is used.

Determination of Tartrates in Cyanide Copper Solutions

By W. B. Stoddard, Jr.

New York.

A rapid method for the determination of Rochelle salt in cyanide copper plating solutions is described. Methods described previously in the literature are discussed. The method proposed involves the precipitation of free cyanide and copper cyanide by an excess of silver nitrate and the precipitate is uniquely coagulated with nitrobenzene. The tartrate is determined by oxidizing with an excess of permanganate and back titrating with sodium thiosulfate.—Ed.

The problem of the determination of sodium potassium tartrate, or Rochelle salts, as this material is commonly designated, has long perplexed chemists who were attempting to control this material in cyanide copper plating solutions. It has already been mentioned by other authors, that round-about methods have been employed because of the lack of a direct and rapid method for tartrate estimation.

Until the present time, at least two articles have appeared in the literature dealing directly with this matter. The author of one of these articles describes a method whereby the tartrate present is separated from the other constituents of the plating solution by a long process of crystallization.[1] Obviously such a procedure, although it may have decided merit, is too time consuming to be employed where quick control results are wanted. The other scheme mentioned is more rapid than the first one described, but involves careful watching during the analytical procedure, requires ventilation and also the time for his procedure is made greater and more difficult because one step involves filtration and washing.[2]

The reasons for the difficulty in determining tartrates are: first, the trouble encountered in separating the tartrate from the other constituents in the plating solution, and secondly, the analytical procedure to be used in actually determining the tartrate. Many standard books on analytical chemistry describe various methods of determining tartrates.[3] These methods are generally titration of the

W. B. Stoddard, Jr.

acid with standard alkali. It is quite plain that the use of standard alkali requires that the tartrate be isolated, consequently to use this method implies the following of a long and complicated separation procedure.

The most acceptable scheme for the analysis of tartrates in plating solutions, is one which does not require the separation of the tartrate in the solid form. In other words, the determination of tartrate content by direct titration of the tartrate solution with some reagent. Because of possible buffer interference, titration of the tartrate solution with standard acid or alkali may not be reliable. Oxidation of tartrates with standard potassium permanganate, on the other hand, under the proper conditions, yields quantitative results which are reproducible. The products of this oxidation are carbon dioxide and formic acid.[4]

The process given below is a rapid analytical procedure for the determination of tartrates in cyanide copper plating solutions which involves no filtration and gives reproducible results with an accuracy of one-half of one per cent.

1. Into a 250 cc. volumetric flask, measure exactly 2 cc. of the plating solution.
2. Add 100 cc. of distilled water.
3. Add a particle of solid phenolphthalein about the size of a pin head.
4. Add dilute sulphuric acid, about tenth normal, until the pink color of the phenolphthalein indicator disappears.
5. Add exactly 5 cc. of nitrobenzene (poison).
6. Add dropwise, with constant shaking, a ten per cent solution of silver nitrate. The endpoint for the silver nitrate addition may be observed when the color of the precipitate changes from white to blue-grey. The silver nitrate removes all of the materials which would ordinarily interfere with the subsequent steps.
7. Shake the flask for a half a

minute or until the precipitate is entirely coagulated by the nitrobenzene. Add a drop of silver nitrate to make sure an excess is present.

8. Add distilled water, making the solution up to the 250 cc. mark.

9. Add exactly 5 cc. of distilled water. This extra distilled water makes up for the 5 cc. of nitrobenzene which was added earlier.

10. Shake the flask well to insure thorough mixing. The solution should now be clear and colorless while the nitrobenzene and the precipitate are present in the bottom of the flask in a dark colored mass which has no tendency to flocculate.

11. Draw out exactly 50 cc. of this solution for the permanganate oxidation.

12. Run this 50 cc. sample into a 500 cc. Erlenmeyer flask. It is advisable to run check samples until this procedure has been mastered, and afterward, depending upon the type of work being done.

13. To the sample, add 5 cc. of 20% sulphuric acid, 5 grams of manganous sulphate, and 100 cc. of distilled water.

14. Heat the sample to 70 degrees C. and add slowly with agitation exactly 20 cc. of tenth normal potassium permanganate.

15. Allow the hot sample to stand for a few minutes and then cool it to room temperature under running water.

16. Add 2 grams of chemically pure potassium iodide. Shake the flask for two or three seconds, and then titrate with tenth normal sodium thiosulphate using a starch solution indicator.

17. Subtract the number of cc.'s of tenth normal thiosulphate used from the number of cc.'s of potassium permanganate, calculated as tenth normal, originally added. This difference when multiplied by 0.0047 gives the weight of the tartrate as sodium potassium tartrate, or Rochelle salts, in the 50 cc. sample. Multiplying this result by five gives the weight of Rochelle salts in 2 cc. of the plating solution. Multiplying this result by 500 gives the number of grams per liter of Rochelle salts. In other words, multiplying the number of cc. of tenth normal permanganate *consumed* by a 50 cc. sample by the factor 11.75 gives the number of grams per liter of Rochelle salts. If the result is to be expressed in ounces per gallon, then the permanganate figure should be multiplied by 1.57.

Discussion of the Procedure

The successful precipitation of all of the constituents of the plating solution depends upon the fact that silver nitrate forms insoluble silver cyanide with sodium cyanide, and that silver nitrate breaks the soluble sodium cyanide-copper cyanide complexes. The products of this decomposition are silver cyanide and copper cyanide, both of which are insoluble. For complete precipitation of these insoluble cyanides, an excess of silver nitrate is necessary.

Under the conditions of the experiment, the silver tartrate formed remains in solution.

The use of nitrobenzene as a coagulant has been described in conjunction with the precipitation of silver chloride. Apparently these insoluble precipitates are coagulated by a selective wetting action of the nitrobenzene. This material, although present in the solution during the permanganate oxidation, remains unaffected and consequently does not interfere with the final result, nor does the excess silver nitrate.

The conditions outlined are the result of many experiments and should be closely adhered to for best results.

The use of potassium iodide and the subsequent titration of the iodine liberated by the excess permanganate, with standard sodium thiosulphate has been adopted because of the extreme difficulty of checking results when the permanganate endpoint was read directly.

The chief source of error in this procedure is the disregarding of the volume of the precipitated silver and copper cyanides. For work requiring greater accuracy, it is suggested that a known quantity of nitrobenzene, sufficient to float and fully cover the precipitates, be used. In a special flask, the volume of this nitrobenzene plus the precipitates could be measured directly and the volume of the water solution could be corrected accordingly.

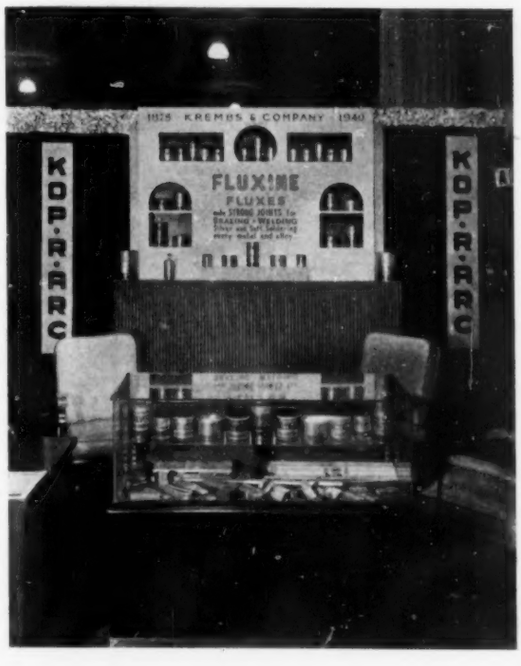
REFERENCES

(1) Simple Methods of Analysis of Plating Solutions, Hanson-Van Winkle-Munning Co., Matawan, N. J., page 35.

(2) L. Weisberg, Determination of Tartrates in Cyanide Copper Plating Solutions, Metal Industry, 35, p. 615, (1937).

(3) Scott, fifth ed., p. 2254.

(4) Pean de Saint-Gilles, Annals de Chimie et de Physique (3) 55, 391.



Krembs & Company's exhibit of fluxes for brazing, welding and soldering, at the recent Metal Show in Chicago.

PLATING AND FINISHING
FABRICATION — ASSEMBLING
METALLURGICAL — ROLLING
CASTING AND JOINING

SHOP PROBLEMS

Technical Advisor For December Issue

G. B. HOGABOOM, JR.
Consultant in Electroplating and Metal Finishing, Newark, N. J.

When sending solutions for analysis please give following information: name and address; class of work being plated; kind of solution and volume; length, width and depth of tank; temperature of solution; current density, cleaning sequence and any other pertinent facts.

Manufacture of Stampers for Phonograph Records

Q. It is our intention to process our own mothers and stampers for making phonograph records due to the economic conditions in our country. We have not been successful in metallizing the original wax or acetate recordings by the use of graphite, and have been told that the ordinary graphite is not suitable for this purpose, and a purer grade is required. We are not able to plate graphite impregnated acetate records, and would like information on how metallizing can be done chemically and any other information you may wish to give on the process of making stampers.

A. Wax recordings are metallized by mounting on a turntable and brushing in lightly a graphite preparation. The preparation is made by adding a solution of silver nitrate to graphite to make a paste. Dry the paste in an oven, then place in a crucible and heat to a red heat. Cool, pulverize, and run through a 200-mesh sieve, or bolting cloth.

To obtain just the right degree of metallizing requires some experience. The brushing should be continued long enough to thoroughly coat the wax, but not too long. The proper point is reached when the record surface has taken on a certain metallic sheen from the graphite coating.

Contact is made from a metal button protruding through from a stud at the back of the record, at the center. The record is suspended by the stud in a copper sulphate solution. The solution used may be:

Copper sulphate	26 ozs.
Sulphuric acid	6 " (av.)
Water to make	1 gal.

Various formulae are used.

The current used may be from 25 to 150 amperes on a 10-inch record. The higher current is possible if the record is rotated rapidly (face down) and if a properly designed anode is used so that excessive current will not go to the edges. Such an anode comes close to the record at the center but slants away as it goes out to the periphery.

Procedures vary considerably. G. Schor in an article on page 418 of the Sept. 1938 issue of *Metal Industry*, describes a method in which the graphited disc is first given a half hour strike in a solution composed of:

Copper sulphate	20 ozs.
Sulphuric acid	2 "
Water	1 gal.

The record is then transferred to a solution such as given above.

When the desired thickness has been built up, the deposit (master) is stripped from the wax, cleaned and given a light nickel plate. (For formulae see Plating & Finishing Guidebook, published by *Metal Industry*).

The nickel face of the mother is given a brushing with a solution of potassium dichromate, in the strength of 1 oz. to the gallon. This provides a stripping film for subsequently deposited copper.

The master is given a light nickel plate and is then plated with copper to form the mother.

This shell is then treated with dichromate, and plated as was done with the mother, and the stampers obtained.

Graphiting of acetate recordings is not successful. They can be coated with a silver film by a silvering process such as Brashears, which uses:

Reducing Solution (can be stored)

Distilled water	700 cc.
Alcohol	175 "
Conc. Nitric acid	3 "
Pure sugar	80 grams

Dissolve the sugar in the water, then add the mixed alcohol and nitric acid. Then add water to bring total volume to one liter. This solution should stand a week before use.

(Other reducing solutions such as formaldehyde 350 cc./liter of water can be used.)

Silver Solution: (must be prepared just before use):

1. Water ..... 50 cc.
   Silver nitrate ..... 1 gram

Add dilute ammonia until the precipitate which forms just redissolves. Then add sufficient other silver nitrate solution to just form a precipitate.

2. Water ..... 100 cc.
   Potassium hydroxide ½ gram

Mix 1 and 2. A precipitate forms. Add ammonia until this just dissolves, then add another silver nitrate solution until just a slight precipitate is formed. This excess is important. The solution should have a brown tinge.

Take 25 parts by volume of the silver solution and add 1 part by volume of the reducing solution, mix quickly and pour on the acetate disc.

Tin chloride solution is sometimes used to treat the surface before adding the silvering mixture, such as:

Stannous chloride .... 1 gram
Alcohol ..... 75 cc.
Water to make 1 liter.

Pour on the disc, allow to remain a few minutes, pour off (do not rinse), then add the silvering mixture.

Objects may also be metallized by the method of cathode sputtering. This has given very good results on record work. A description of this process appeared in the Nov. 1932 issue, page 429, of *Metal Industry*.

—G.B.H., Jr.

Pitting in Nickel Solution

Q. We are having considerable trouble with pitting and peeling on our solid steel shears. Pitting is only on the tempered blade. The carbon content of this steel is 0.60 to 0.65. We are now using 100-volume hydrogen peroxide in our solutions to prevent pitting. We also use the 99% depolarized anodes, bagged as recommended. These solutions are used in still plating, the old fashioned way, temperature being approximately 85° F. The pH, we try to hold at 5.8. After the work is cleaned, which is done with direct and indirect current at 8 volts, same is rinsed in hot and cold water. Then dipped in HCl solution, rinsed again in cold water and placed in nickel bath.

We put four or five blades to a wire and it takes approximately one minute to hang these on the work rod, after same have been placed in the bath before the current is turned on.

With the above in mind we would appreciate your answering the following questions:

1. How often must hydrogen peroxide be added to prevent peeling and what quantity?

2. How and when should the peroxide be added?

3. Will the peroxide change the pH?

4. Should the pH be tested before or after the peroxide has been added?

5. Will peroxide added to the solution oxidize or tarnish the work if the current is not immediately applied?

6. Will leaving the work in the bath, as explained, without current for one minute cause oxidation resulting in peeling?

A. 1. The amount and the frequency of additions of hydrogen peroxide are quite variable. It is better to add the peroxide in small doses at frequent intervals rather than making large additions every now and then. The best thing to do is to make the addition at the end of the day, when the solution can be stirred and the peroxide given a chance to react. One reaction is the oxidation of iron to ferric hydroxide which precipitates.

Start making small daily additions, say one or two ounces of 100 vol. peroxide to each 100 gallons of solution. If pitting is noted, the next day increase the addition. When the point has been reached where pitting is controlled, a practice should be established of making the same addition every day. Experiment may show that the amount of this addition may be reduced slightly after pit free operation is obtained.

2. Rather than the single daily addition, the peroxide can be added dropwise continuously by arranging the bottle on a shelf and conducting it to the solution by a glass tube. This method is good when it works right, but controlling a slow dropping is a difficult matter to set up for the average plating room. When a syphon bottle is used the rate of dropping changes as the level of liquid in the bottle falls. If an inverted bottle is used with a stopcock for control, the rate will increase rapidly as the air space in the bottle expands when the room warms up. Also, a slightly open stop-cock clogs very easily from small particles of dirt. A good method for obtaining slow feed of a liquid, but which has not been used for obvious reasons in a plating room so far as known, is to slowly let down a plunger, by clockwork or geared motor, into a cylindrical vessel containing the liquid. The sinking plunger gradually displaces liquid over an overflow which can be a large tube with no small orifices to clog up.

3. If there is an appreciable amount of ferrous iron in the solution, the addition of peroxide will cause the pH to fall. Small daily additions of peroxide normally will not cause much change in pH.

4. In order to have a check on the behavior of the solution, taking the pH before and after adding peroxide would be a good idea. After standard practice has been established, this may be unnecessary.

If one pH check is made, make it after adding the peroxide, and correct to the desired value.

5. Work placed in a solution to which peroxide has just been added is liable to tarnish. An idea of the amount of available oxygen in the solution after a peroxide addition, can be had by taking a small sample in a beaker or test tube, warming, and adding a pinch of pumice. The solid points presented by the pumice causes the oxygen to be released. If much oxygen is seen to be evolved, then a similar action will occur on metal surfaces in the solution. Applying the current will not entirely stop the tarnishing action. This is one reason for not adding large amounts of peroxide at one time.

6. When hanging work in the tank, a small current should be on. Use the lowest point on the rheostat. If about ½ volt is applied while the tank is being loaded the danger of chemical action on the steel will be reduced. Leaving work hang in the solution for any length of time without current can very definitely be a cause of peeling, due to the formation of products on the surface that prevent the close contact of the deposit with the steel base.

Scissors cannot be plated as rapidly as cold rolled steel or brass and not over 2 volts, should be used.

ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—FINISHING—RUST PROOFING—LACQUERING

Bright Dipping of Stainless Steel*

A method is described for treating nickel-chromium alloys to markedly reduce the tendency to pit corrosion. In addition, this treatment imparts a beautiful luster to stainless steels which is similar to that of precious metals.

Introduction

With the use of stainless steels, two types of corrosion difficulties have been experienced: (1) intercrystalline; (2) pit corrosion. Intercrystalline corrosion is a form of corrosion which is engendered and developed along, or adjacent to the grain boundaries of the alloy. It was generally concluded that this form of corrosion was caused by the depletion of chromium in the area of the grains adjacent to the grain boundaries by being taken up by the carbon to form carbides. This type of corrosion has been overcome by proper control of carbon content, heat treatment and by the addition of alloy constituents, such as titanium or columbium, which present a preferential affinity for the carbon, thus effectively precluding the removal of the passivating chromium from the grains.

Pit corrosion is a peculiar and particularly dangerous type of attack which is characterized by a series of segregated pits, which progress perpendicularly into the body of the steel, ultimately producing a type of honeycomb structure. The evident cause of pit corrosion appears to be due to the mechanical imperfections in the surface of the steel established as a result of the cold working. These imperfections may be declivities, cracks, pits and the like.

A previously patented process overcomes pit corrosion by a heat treating process which involves the vacuumizing of occluded, dissolved or adsorbed materials in the alloy.

A method described in this patent has been developed for chemically eliminating the surface imperfections to prevent pit corrosion, and this treatment is in sharp distinction with the usual methods of oxide or scale-removal by pickling.

In the present method, a strong acid is employed for the sloughing or dissolving action and the activity of the acids is increased by utilizing elevated temperatures so as to insure positive and appreciable dissolution of the metal surface. This is in counter distinction to ordinary pickling methods which seek to prevent surface attack; for example, by inhibitors or by electrolytic means. The susceptibility to pitting was determined by utilizing the following solution for accelerated pit corrosion:

Ferric chloride	100 grams
Hydrochloric acid (2.45N)	20 cc
Water	1 liter

To test the solution described, a series of stainless steels, essentially the 18-8 type, was subjected to varying degrees of cold working, ranging from 2 to 50 per cent reduction, and when tested by the above described solution, marked pit corrosion was evident with the specimens untreated in the acid solution herewith described.

The formulæ for the treating bath may vary considerably and the following formula is typical.

Hydrochloric acid (commercial)	30 grams
Sulphuric acid (commercial)	40 "
Nitric acid con.	0.5 "
Titanium tetrachloride ($TiCl_4$)	5.5 "
Water	24 "

Temperature 70°-80° C.
Time from 2 to 5 minutes or more.

In making up the solution, a portion of the hydrochloric acid was diluted with an equal amount of water and this was slowly added to the titanium tetrachloride. The solution was rapidly agitated until all of the intermediate reaction products were dissolved and the remainder of the formula was then added. The solution herewith described evidently dissolves off surface metal to the order of 0.0004" to thereby eliminate pit engendering mechanical imperfections on the surface, and in addition *produces a singular luster and coruscation* which is totally unexpectable in a ferrous alloy and is equivalent to that which characterizes precious metal, such as silver.

It will be appreciated that the formula given herewith is indicative of the general type solution to be employed. Manifestly, the relative concentration of the acids in the formula may be varied. Similarly, the percentage of titanium tetrachloride may be varied over a considerable range.

It has been found that concentrations of from 4 to 7 per cent by weight of the final solution insures the desired improved results. The length of time to which a particular article is subjected to the resurfacing solution likewise may vary, depending upon the previous history of the article; or in other words, the amount of resurfacing that is necessary to secure the desired pit inhibition. While pit susceptibility of passive ferrous alloys may be considerably increased by cold working, this cause is not the sole one for the initiation of pitting, as it has been found that inhomogeneities of the surface, such as inclusions of slag, oxides, sulphides and the like, of themselves tend to induce pitting. In addition, the inclusions would appear to have an important bearing in the initiation of the cracks, checks and fissures, inasmuch as mechanical imperfections tend to originate at heterogeneous interfaces.

The treatment described, therefore, serves not only to dissolve off the mechanically imperfect metal, but also to remove the inhomogeneities in the metal.

*A resume of patent No. 2,172,421 by H. H. Uhlig, Cambridge, Mass., entitled "Corrosion Resistant Ferrous Alloys". This patent was applied for on May 15, 1937 and was issued September 12, 1939, and has been assigned to the Chemical Foundation, Inc., New York City.

Means and Method for Producing Metallic Screens. U. S. 2,166,366. July 18, 1939. Granted to E. O. Norris. According to the inventor, wire screens can be produced by electrodeposition. The method is something as follows: (1) Photographing the screen design by photographic manipulation of a half tone screen, (2) From the negative, printing the design on a sensitized copper plate (ammonium bichromate is the light sensitive medium), (3) Developing, (4) Etching out undeveloped portions with ferric chloride, (5) Filling in recesses with a resin resist, (6) Plating on the pattern. Various types of screening can thus be manufactured.

The Estimation of Oxygen in Metals. By W. A. Baker. J. Inst. Metals, 1939, 65 (Advance copy).

A sensitive method is described for the detection and estimation of oxygen in metals. Oxygen in the metal is converted to water vapor by heating the specimen in contact with a moderate excess of pure hydrogen under reduced pressure. The water vapor is collected in a condenser at —80° C. and is subsequently vaporized in an evacuated system and the amount determined by observing its vapor pressure.

Apparatus for Electrodeposition of Continuous Gold Film. U. S. 2,164,010. June 27, 1939. Granted to W. F. Grupe. Assigned to the Peerless Roll Leaf Co. The apparatus consists of an equipment for plating gold continuously on a carrier from which the gold is subsequently separated and carried on to a paper interleaving material. This takes the place of gold beater's leaf made by the old hammering method.

Post Scripts

A little over a year has elapsed since the first appearance of Post Scripts and, in the main, the readers' comments have been favorable. A few readers from Detroit have said that Post Scripts should be eliminated as it has no place in a serious technical magazine.

The writer is not asking the readers to write their opinions because, from previous experience, no one would answer anyway. The best way to get written response is to make some gross error which I am often tempted to do deliberately. To strike a happy medium, Post Scripts is one page in this issue.

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Detroiters Go A-Hunting

Carl Heussner took several of the members hunting, and the reporter overheard that it was a hunting trip deluxe, as Carl was a perfect host, and his sister-in-law cooked a most excellent chicken dinner.

Lindahl is a crack shot, nobody denies that, but he isn't quite so particular what he shoots at, at times.

Jim Higgins claims he shot at half a dozen pheasants but in view of the fact that the rest of the boys claim they shot first, and jumped the fence quicker and retrieved the birds, it was difficult for Jim to attain his quota for the day on that basis. But we wonder how he will explain to the game warden about the picture he had taken showing him holding about 8 pheasants in each hand.

Heussner was such a Scotchman that in order to win a 25c bet that he would hit a pheasant the first time he fired the gun, he carried the gun all morning without firing a shot in order to win his bet.

Mose Cherry was either too tenderhearted, or saving on shot gun shells to kill birds except with a stone in the hand, and lots of encouragement from the other fellows on the fence.

Jim Higgins is pretty good at target practice when it comes to blowing holes in mother earth. However, he claims that if somebody hadn't oiled the gun, it wouldn't have gone off unexpectedly.

The fellows who went hunting still feel so cocky that they will take on all comers from any other Branch to decide the best crack shot. Hot-Nose Reporter.

As long as we are on the subject of hunting, *George Merz*, who peddles chemicals for the Harshaw Chemical Company in New York State, should be awarded some sort of honorable mention. George just came back from an Ontario moose hunt this Fall with the record head the picture shows below, showing the head

hanging in Merz' backyard with his two-and-a-half year old daughter using the lower part of the antler for a swing seat. Merz is sure that his many friends in industry will be glad to know that the moose antlers measures 63″ from tip to tip. George's feat was duly acknowledged in the Cleveland Press. I can just imagine *Gene Phillips* after reading this story say, "Oh, yeah?"

•

A fat lady stepped on the scales, not knowing it was out of order, and put in her penny. The needle went up to 75 pounds—and stopped.

An inebriated gentleman who was watching intently, staggered.

"My Lawd!" he said. "She's hollow."

•

The Philadelphia banquet et cetera was a successful affair with a large attendance at both the educational session and banquet. The floor (stage) show must have been good as everyone was sorry it was so short.

Only a few members were present from the Newark Branch as all the members were greatly depressed by the passing of *Oliver J. Sizelove*. *George Wagner* and *Phil Sievering* were among the few Newark members who were present.

Bob Jackson and *Al Hirsch* were upset by an incipient comic brawl between a one-eyed Connelly and a kind Samaritan. It happened so—A member in fun put a brush up to his face and said, "Heil Hitler". Aforementioned One-Eyed Connelly lurched forward to crush said Comic and in stepped Kind Samaritan to insure peace. O-E Connelly swings, Comic ducks, and Samaritan gets hit with a round-house. See how easy it is to get into war.

•

The monthly appearance of M.I. at the main offices of Hallenscheid and McDonald, in Los Angeles, has been threatening to 'cause a miniature Civil War, according to *Don M. Bedwell*, who is associated with that firm. If *G. A. Hallenscheid*, the senior partner in the bathroom fixture manufacturing firm, chances to get his hands on the magazine first, Bedwell declared, every one else on the staff has to wait—patiently, if possible—until the boss has finished with it. Many an argument has been waged, Bedwell reported, because Hallenscheid takes his own good time in perusing the magazine from cover to cover. Some months Bedwell doesn't get to see it until a week after its arrival, so he went into a Brain Trust huddle with himself and came up with a simple, but effective, solution:

Bedwell has taken a year's subscription to METAL INDUSTRY in his own name and is having it sent to his home, far removed from the clutching hands of G. A. Hallenscheid. The moral of this story seems to be that if partners wish to insure against disrupting their organization, they had better take two subscriptions to the object which is generating the dissension. (Plug).

•

Clarence "Chick" Helmle, G.E. electrochemist, called our attention to a word error in his shop problem on floors in the November issue. His manuscript had the word "screeding" which we took for a typographical error and changed it to "screening". Chick says "screeding" is right and its even in Webster's.

•

Walter Kidde & Company recently gave a demonstration of their new fire-fighting equipment and gave a luncheon preceding the demonstration, with the following menu:

Fire Water
Manhattan et Martini
Appetizers Arsons
Fruit Cocktail du Carbon D
Consomme 'Sirene
Chicken Combustion
Pyromaniac Potatoes Peas a la Hydrant
Fiorello Salad
Dri-ice Creme Hose Cake
Cafe au Leary

•

Merry Christmas

Walter R. Meyer

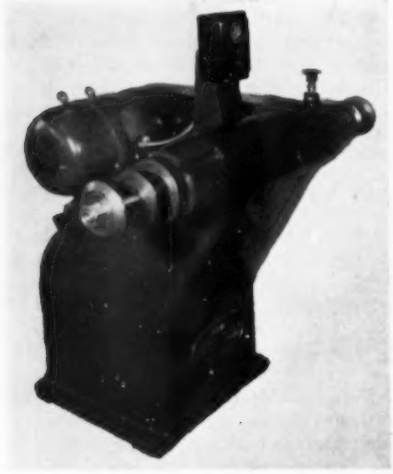
NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

New Polishing and Buffing Lathe

Illustrated is Rome Machinery Sales & Engineering Co.'s new Model "MOS" Polishing and Buffing Lathe, equipped with a 5 h.p. motor.

This machine is modernly styled and has been designed to provide convenient operation with a minimum amount of maintenance. The base is arranged with an overhanging wheel spindle and is cast of heavy section grey iron. The SAE alloy steel wheel spindle is ground to size and is accurately balanced. Spindle ends are machined with flat top (Acme form) threads and fitted with bronze spindle nuts. To permit the assembly of taper point attachments, each spindle end is tapped and counterbored. Wheel spindle is mounted on high capacity, precision ball bearings with effective enclosures that permit lubrication with oil or, if desired, with grease by the cavitation principle. Grease lubricated bearings on this machine operate for periods extending over six months without attention.



Polishing and buffing lathe.

Plunger actuated spindle lock engages a four station member, positively anchored to wheel spindle, to facilitate mounting and removal of wheels. Multi-V belt spindle drive is entirely enclosed by a substantial cast guard which includes a removable cover plate for belt inspection. To provide extreme belt life and proper operating tension under all load conditions, the continuous duty, totally enclosed, fan cooled, ball bearing motor is mounted on an automatic tension controlled base. Motor starting switch is bracket mounted, accessible to operators and in a position readily connected to service lines. Motor and starter are wired electrically.

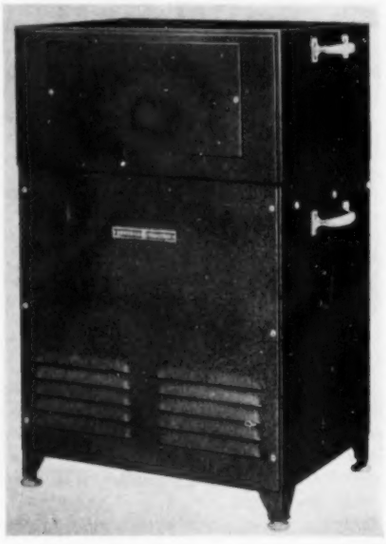
The Model "MOS" lathe is available in h.p. ratings, to and including ten horsepower. Spindle diameters at wheels and spindle r.p.m. to customers' specifications.

Spindle nut wrench, standard equipment. Various accessories including taper screw points, variable speed spindle drive, tool shelf, start-stop-brake lever control for spindle, dust hoods with mounting brackets, composition applicators can be supplied as optional equipment.

For further information write Rome Machinery Sales and Engineering Co., 627 Webster St., Rome, N. Y.

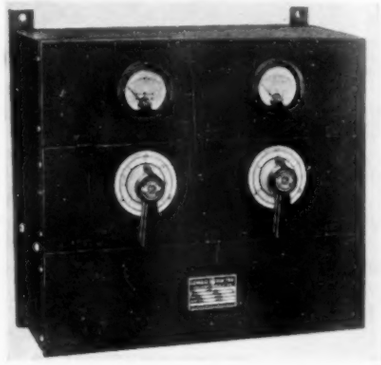
Copper-Oxide Rectifier and Voltage Regulator for Electro-Plating

A fan-cooled copper-oxide rectifier suitable for electroplating service has been made available in several ratings by the General Electric appliance and merchandise department, Bridgeport, Conn. To give the operator complete control at the tank, a separate voltage regulator is also available.



Rectifier unit for electroplating.

The new rectifier is an adaptation of the G-E fan-cooled copper-oxide rectifier that has been used successfully in motion picture service and in various industrial applications. In applying the rectifier to electroplating, separate units can be used for each electroplating tank in place of a large unit serving several tanks, as is customary with rotary equipment. With this economical arrangement, approximately full-load efficiency can be maintained at all times because rectifiers can be shut down on any tank not being used. A further advantage claimed is that each rectifier can be adjusted to the voltage required by its particular tank, thus eliminating the use of a tank rheostat with its inherent losses.



Hand-operated voltage regulator.

The rectifiers are built up from standard sectional units to obtain flexibility in output capacities. Each unit, or section, is a complete rectifier in itself with an output capacity of 1.8 kilowatts. Two direct-current ratings are available, in 6 volts and 12 volts. The standard six-volt sectional unit is rated 300 amperes, and the 12-volt unit is rated 150 amperes. By paralleling two or more sections any desired current capacity can be obtained.

The G-E hand-operated voltage regulator, for use with these rectifiers, provides a simple and convenient means of adjusting the voltage output of the rectifier. Several sizes are available, so that any number of

Professional Directory

G. B. HOGABOOM, JR. & CO.
Consulting Chemical Engineers
Solution analysis, plant design, process development. Testing of deposits—composition, thickness, porosity, salt spray.
352 Mulberry St. Newark, N. J.

J. B. KUSHNER, B.S., Ch. E.
"Personalized Plating Service"
Plating bath analyses made on your premises. Installations. Advisory service.
192 Broadway, N. Y.
COrtland 7-1156

"Universal" method

SAVES 90% OF REJECTS!

Adding 1% Nickel saved Universal Brass Mfg. Co., Los Angeles, 90% of former losses from shrinking and cracking of swing spout fixtures.

Shrinks and cracks forced remelting of one out of every four. This was the sad story of swing spout sink fixture bodies cast by the Universal Brass Manufacturing Co., Los Angeles. Thirty per cent of scrap is used for their melts. Many remedies were applied. But rejects still ate the heart out of profits.

Then someone recalled what is done with brass and bronze castings—used to control high pressures. Methods for production of pressure castings were suggested and now Nickel is added to their melts to refine the grain. The mixture containing about 1% Nickel cuts rejects down to 3%—instead of their former 28% loss.

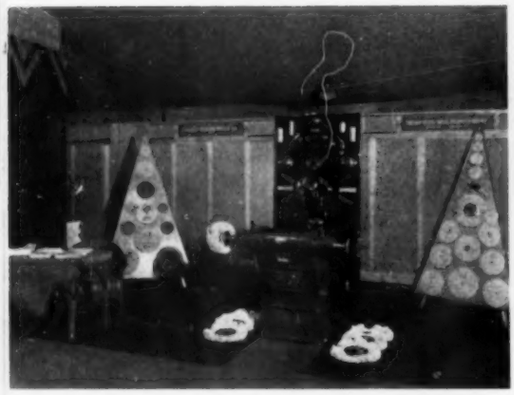
Nickel permits easier casting of intricate patterns by increasing fluidity and reducing porosity. Even in the absence of virgin metals, Nickel promotes uniformity. Write for more information on how Nickel cuts casting costs by cutting down the percentage of rejects.

NICKEL

Brasses and Bronzes

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

Exhibits at National Metal Show In the Plating and Finishing Industry

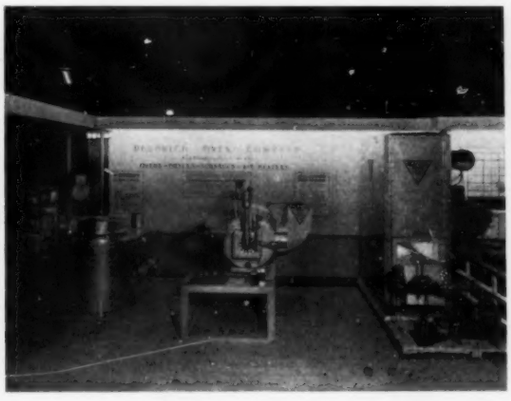


Advance Polishing Wheels, Inc., Chicago, Ill., exhibiting new Permacore buffs and Pioneer wheel, and Matchless Metal Polishing Co., Glen Ridge, N. J., exhibiting new stainless steel composition.

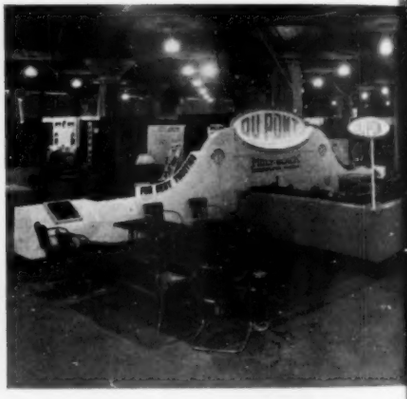
Binks Mfg. Co., Chicago, Ill., with a display of finishing units for all metal products including a dynaprecipitor.

Continental Roll & Steel Fdy. Co., E. Ch Ind., exhibiting double-action polishing buffing machines.

Crown Rheostat & Supply Co., Chicago, Ill., exhibiting in operation slow speed method of polishing; also new laminated cylinder, rheostats and centrifugal dryer.



Despatch Oven Co., Minneapolis, Minn., exhibiting new indirect gas-fired air heater for ovens, dryers, etc.



E. I. duPont de Nemours & Co., Inc., Wil ton, Dela., exhibiting new "Molyblack" p process.

Handy & Harman, New York, exhibiting a high speed production brazing job; also brazing fluxes and alloys.

Chas. F. L'Hommedieu & Sons Co., Chicago, Ill., exhibiting plating generator, variable speed polishing lathe and other plating equipment.

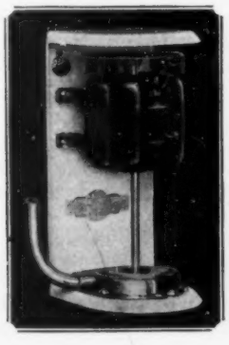
N. Ransohoff, Inc., Cincinnati, Ohio, exhi conveyor type metal cleaning machin

parallel rectifier units from one to seven can be controlled simultaneously from one regulator.

The regulator may be installed conveniently near the plating tank although the rectifier may be some distance away. The voltage regulator has 36 steps of adjustment, giving a voltage range from maximum down to one volt. In addition to voltage adjustment, the regulator provides control for starting and stopping the rectifiers. It includes an accurate ammeter and voltmeter to give the current and voltage at the tank. This method of control provides the convenience of an individual tank rheostat but eliminates rheostat losses. The regulator is connected ahead of the rectifier so that the latter never operates at full load unless maximum voltage is required at the tank.

Acid Resistant Pump

A new pump made of stainless steel and mounted on a vitreous porcelain enameled stand has been developed by the Air-O-Line Company, Dallas, Texas. The pump is made in three sizes ranging from 140 to 360 gallons per hour, and it is claimed to be one of the most efficient small pumps ever developed in the low price field.



Stainless steel pump.

The pump is recommended for transferring corrosive liquids, such as plating solutions, pickling solutions, etc.

A folder describing this pump can be secured by writing to the manufacturer.

Tubular Lead Anode for Chromium Plating

A tubular design of lead plating anode, stated to give unusually even throwing power and low resistance for the current discharge surface available, is being manufactured by Acme Lead-Burning Company, 3726 West 73rd St., Cleveland, Ohio. It may be supplied either in pure lead or in 6% antimonial, as may be specified. This type of anode is particularly recommended for the center anode busbars of a tank, because of the equal current distribution on all sides. For the anodes of the side busbars, a semi-circular pattern is recommended; or the ordinary flat anodes may be employed. It is claimed that because of the simple design and the smaller amount of lead needed, these tubular anodes cost less than the regular flat ones.

Do You Want To?

1. Lower your water costs 38 to 86%?
2. Shorten rinsing time up to 65%?
3. Rinse your work more effectively?
4. Minimize spotting and staining?
5. Eliminate "carry-over" contamination?
6. Cut your alkali and acid costs?
7. Reduce number of rinse tanks?
8. Decrease Sewage Pipe Loads?

ALL WITH ONE EASY MOVE?

●

OTHERS ARE FINDING IT EASY TO DO SO WITH

"VORTEXEDDY"

SPRAY RINSE TANKS

●

Our Free, No Obligation, Booklet,

"RINSING WITH SPRAY THE STORTS WAY"

Gives You All The Particulars

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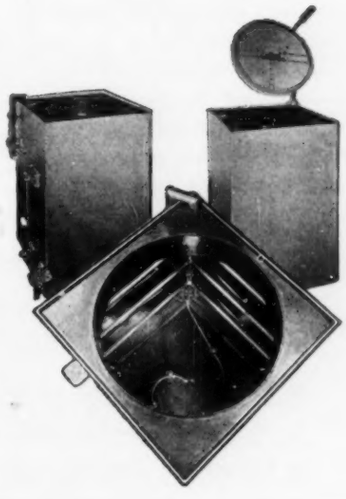
Be Sure to Mention

"METAL INDUSTRY"

When You Write for It



STORTS WELDING COMPANY

42 STONE STREET MERIDEN, CONNECTICUT

Manufacturers of Welded Fabrications to Specification

New Anode Bags

A new anode bag, "Style D," is the latest development of the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies.

"Style D" bags are made from a closely woven Sanforized drill material. They are 5″ wide, single ply with a special sewing. For anodes 12″ to 20″ long the bags are 4″ longer than the anode. Anodes 20″ to 40″ long require bags 5″ longer than the anode as there is more room needed for the collection of sludge.

In place of draw strings these bags are fastened to the anodes by two pieces of tape which pass through holes punched through the bag ½″ down from the top.

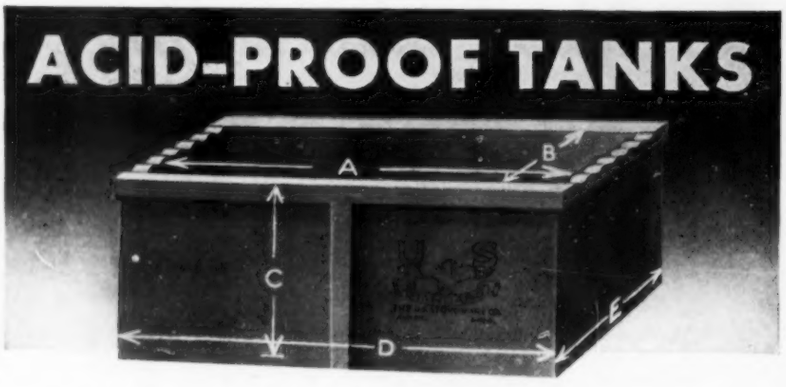
The bags are impregnated top and bottom with a red resin. On bags for anodes 12″ to 20″ long the tops are coated 3″ down and from the bottom 3½″ up. On longer anodes (20″ to 40″) they are coated 3″ down from the top and 4½″ up from the bottom.

The advantages claimed for these bags can be summed up as follows:

1. The impregnated resin tip greatly prolongs the life of the bag. It has been found in many plants that the anode bags fail first near the top, where they are alternately exposed to solution and air due to the changing solution level caused by evaporation or by the type of agitation employed. Where low pH solutions are used very early failure often occurs at this area with ordinary bags.

2. The resin coated bottom of the bag forms a pocket for the sludge, largely carbon, which accumulates as the anode corrodes. Carbon particles are very fine and we have observed in many instances that these particles work through the mesh at the bottom of the bag and cause rough deposits. This is especially true in solu-

ACID-PROOF TANKS



Made of "DENSTONE"—an Acid-Proof Chemical Stoneware, dense-bodied and non-porous, and made from De-Aired (Vacuumized) clays.

All tanks are unqualified y recommended for electroplating, galvanizing and pickl'n- work. The dense, granite-like body is acid and corrosion-proof all the way through.

Gal.	Length in Inches	Width in Inches	Depth in Inches	List Price
4	12	9	9	$14.00
10	16	12	12	23.00
16	20	16	12	32.40
26	24	16	16	42.00
38	28	20	16	65.00
41	24	20	20	66.00
44	32	20	16	78.00
66	32	24	20	96.00
69	40	20	20	104.00
104	36	28	24	140.00
119	48	24	24	152.00
149	60	24	24	206.00
210	48	32	32	248.00
320	72	32	32	360.00

Special sizes made to order. List prices subject to discount.

Write for information about our CORROSION-RESISTING TANK LININGS for:

- Pickling Tanks for stainless-steel
- Plating Tanks for bright nickel, copper, etc.
- Chromium Plating Tanks
- Pickling, Cleaning and Plating Tanks for all purposes

THE U. S. STONEWARE CO.
WORKS (SINCE 1865) AKRON OHIO

tions that are agitated. The carbon fills the bottom of the bag as the anode corrodes and with even a small amount of agitation this pocket is thrown against the tank wall with sufficient force to cause carbon particles to work through. The carbon cannot work through the resin-impregnated bottom of the bag. Consequently the solution is kept cleaner and the deposit is smoother.

3. With the top of the bag stiffened by the resin, a much simpler method of fastening the bags to the anodes is possible. There are no draw strings to pull and the cloth is not bunched around the hooks to act as a wick, and draw solution up by capillarity. Under such conditions, when the solution evaporates an unsightly crystal formation remains which becomes stiff and makes subsequent removal of the bags difficult.

With the new simple closure the tops of the anodes stay clean and the bags are easily placed and removed.

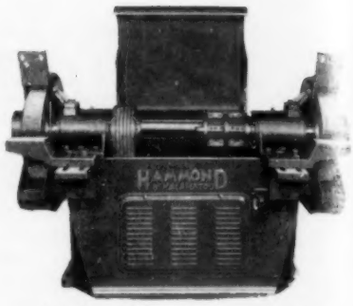
4. The proper solution level can be determined at a glance. The solution level is normally somewhere along the red portion of the bag. As soon as the white cloth shows it indicates that water is needed to restore the proper level.

New Grinder

A new addition to the Hammond line of grinders built by the Hammond Machinery Builders, Inc., Kalamazoo, Mich., is the type "WR" Single Speed Machine herein pictured.

Although shown as a single speed machine with 20" diameter wheels, this same type grinder may be had with 2, 3 or 4 speeds, for 24 to 30" wheels and with motors up to 20 h.p.

The type "WR" grinder has a motor



Grinder for extra heavy jobs.

mounted in the base with a Multi-V Belt Drive. The spindle is 3⅞" diameter, of high carbon ground steel and is in two pieces which are joined by the coupling as shown. When changing belts, it is unnecessary to disturb the spindle assembly. You merely unscrew eight cap screws in the arbor coupling, to permit the belts to pass between the ends of the arbor.

This is stated to be an excellent grinder for those "extra heavy" grinder jobs and for further particulars write the Hammond Machinery Builders, Inc., 1601 Douglas Ave., Kalamazoo, Mich.

Silver and Hard Solder Flux

Lloyd S. Johnson Co., 2241 Indiana Ave., Chicago, Ill., have recently announced the development and marketing of a compound called "Lloyd's No. 7 Silver and Hard Solder Flux," which has been developed primarily for the purpose of silver and hard solder. The flux begins to fuse at about approximately 850° F., and at 1150° F. it becomes thoroughly liquid and continues to flow evenly, maintaining its volume at high temperatures of 1600° and upwards, without breaking down or dissipating itself before complete cleansing of oxides and foreign matter from the metal surfaces has been accomplished.

The flux is stated not to spatter or bubble excessively at high temperatures, thus obviating frequent causes for spots and stains on the metal adjacent to the joint. Thus the flux, according to the manufacturers, maintains its efficiency, both for high melting and low melting applications. The material is quickly soluble in water and is easily washed off from the finished work.

It is packed in a paste form in jars and is applied with a brush. It does not harden or cake and is said to retain its paste-like consistency indefinitely. The flux can be used for dip fluxing by adding a sufficient quantity of water.

It is recommended for soldering of metals, such as gold, silver, copper and nickel as well as many alloys which include Monel metal, Inconel, brass, bronze and many ferrous alloys.

Improved Die Mold Dressing

St. John X-Ray Service, Inc., 30-20 Thomson Ave., Long Island City, N. Y., have announced an improvement in their mold dressing compound called "Bonis", which has been on the market for over twelve years.

Technical developments have enabled a more uniform quality to be maintained

and the development enables its use for aluminum and brass casting. The dressing is a chemical compound supplied in concentrated form, and for use, a few ounces are dissolved in a quart of water. The solution is spread by means of air pressure over the hot metal surfaces, such as dies, permanent and semi-permanent molds, ingot molds, pots, ladles, nozzles and goosenecks on die casting machines and the like. After the water is evaporated, a fine powder is said to penetrate into the minute pores and possible cracks in the surface of the metal. When brushed evenly with a soft brush, this coating is claimed to give a perfectly smooth surface, which results in a perfect surface on the casting, and which is stated to come out of the die much cleaner than if no mold dressing was used.

As a result of the improved finish, the manufacturers claim that less buffing and cleaning is required before subsequent plating or finishing.

Bonis acts as a lubricant and insulator and at the same time is non-inflammable and non-poisonous. One application is said to be sufficient for at least 300 zinc base die castings, and it is stated to have an additional advantage on ingot molds because of its deoxidizing qualities, thus resulting in at least 2½% more useful metal from such treated molds.

Manufacturers' Literature

Aerial Grinders. A 15-page catalog describing a complete line of aerial grinders manufactured by Sawyer Electrical Mfg. Co., Los Angeles, Calif. It includes a description of their high speed, heavy duty tool post and pedestal mounted models, with information on pressure blowers and volume blowers. A complete line of grinders and sanders is included.

Buffing Lathes. Bulletin No. 53 of the Hisey-Wolf Machine Co., Cincinnati, Ohio, describes the new Hisey infinitely variable speed buffing and polishing machines, which feature a wide range of speeds with easy control.

Centrifugal Pumps. A 4-page folder illustrating the balanced monobloc centrifugal pumps of Worthington Pump & Machinery Corp., Harrison, N. J. The folder includes a phantom view showing various parts of the motor and pump. These pumps are recommended for air conditioning installations and chemical process work.

Dilatometer. The Bristol Co., Waterbury, Conn., have announced their new Rockwell-Bristol dilatometer in a 4-page bulletin No. 546. The instrument is a direct reading dilatometer, which both indicates and records in ink, time-dilatation changes and temperature-dilatation changes simultaneously during heating and cooling cycles of ferrous and non-ferrous metals, ceramics and other rigid materials.

Our Regular Type Buff

Our Type "A" Buff

Type "K" Buff

Buffs are an Important factor in production

If finishing departments are to run smoothly—keep output at peak—consider well the buffs used in the polishing room.

BIAS types are constructed for all classes of work.

Regular type is for general work and for color work.

Type "A" has a wide cutting face, uses little compound—wonderfully efficient.

Type "K" is for heavy cutting down work—has a hard face, a fast economical worker.

Give these buffs a trial.

BIAS BUFF & WHEEL CO., INC.

428 Communipaw Ave., Jersey City, N. J.

Generator-Voltage Regulators. A 4-page folder illustrating new generator-voltage regulators sold by General Electric Co., Schenectady, N. Y. Curves are given for regulators for self-excited exciters and for regulators for separately excited exciters.

Glaziers' Equipment. A 66-page catalog issued by Landon P. Smith, Inc., Irvington, N. J., describing tools and equipment for glaziers. The equipment includes glass cutters, glass holders, scrapers and various types of puttying tools.

Laboratory Ovens. Precision Scientific Co., 1750 N. Springfield Ave., Chicago, Ill., in their bulletin No. 305 have given a practical discussion of heat transfer as applied to constant temperature laboratory equipment. Included are a brief review of heat transfer principles and an outline of technical considerations affecting rate of heat transfer, variations in quantity of heat required, attributes of peak performance, and various aspects of efficiency.

Maintenance Methods. Porter-Cable Machine Company, Syracuse, N. Y., in a 24-page booklet entitled "Modern Maintenance Methods" give helpful information on sanding, polishing, cleaning, refinishing of walls, floors, etc. The booklet includes many illustrations of how to use Porter-Cable portable saws and other tools.

CUT PLATING COSTS

WITH THIS NEW *Longer-life* RACK COATING

DEVELOPED by United Chromium, through extensive research, "Unichrome" Rack Coating-W possesses the following outstanding advantages:

1. Withstands boiling cleaners and all plating solutions.
2. Tough—withstands wear and tear of normal handling.
3. Contains no ingredients harmful to any plating solution.
4. Cuts costs—by greatly reducing the frequency of recoatings.
5. Easy to apply—by "dip and force-dry" method.
6. Light in color—easy to see how completely the rack is covered.
7. Any part of rack can be recoated without necessity of recoating entire rack.

Thoroughly proved in actual service—and now regularly used by many plating shops—this new rack coating material has produced amazingly fine results. Reports show that some racks coated with this material have gone through over 1,000 plating cycles without any insulation breakdown.

Write for Bulletin No. 27 containing complete information

Platers without rack dipping and drying facilities may have their racks coated with "Unichrome" Rack Coating-W by making arrangements with Chromium Corporation of America, 4645 West Chicago Ave., Chicago, Ill., or Lea Manufacturing Co., Waterbury, Connecticut.

UNITED CHROMIUM
INCORPORATED

51 East 42nd Street, New York, N.Y.
2751 E. Jefferson Ave., Detroit, Mich.
Waterbury, Conn.

*Trade Mark Reg. U.S. Pat. Off.

Metal Cleaning Machinery. "Metal Cleaning Machinery for Improving Product and Reducing Production Cost" is the title of a folder recently published by N. Ransohoff, Inc., 210 W. 71st St., Cincinnati, Ohio. The folder describes and gives illustrations of various equipment for batch washing and drying of metal parts.

Metal-Working Products. A well illustrated 20-page booklet describing the products of E. F. Houghton & Company,, Philadelphia, Pa., for the metal working industries. The booklet contains data and illustrations on cutting and grinding oils, hardening compounds, quenching oils, cleaners, core oils, iron blackening compounds, pickling inhibitors, greases and various other products.

Pattern Compound. "Super Tamastone" is the title of a two-color catalog just issued by Tamms Silica Co., 228 N. LaSalle St., Chicago, Ill. Information is also given on a new line of Pyramid pyrometers for accurate temperatures of molten metals; skimmers for scientific assurance against contamination are also described.

Pickling Equipment. An attractive 4-page bulletin of the Klaas Machine & Mfg. Co., Cleveland, Ohio, entitled "Everything for the Pickling Room," illustrates baskets, crates, cylinders and other containers made by this company for pickling.

Pyrometers. The Pyrometer Instrument Co., 103 Lafayette St., New York City, in a recent bulletin describe and illustrate their molten metal wall-type pyrometers. Any of the three types of indicating pyrometers may be conveniently mounted on the wall near the metal pot and connected to a hand-type thermocouple with protected type thermocouple tip for brass or bronze readings or with ordinary bare metal thermocouple for these and other metals such as aluminum, etc.

Pyrometers. A six-page folder describing optical pyrometers available for measuring temperatures at a distance. The folder describes a new bi-optical pyrometer and also a micro-optical pyrometer, which is used for measuring the temperatures of small objects for laboratory and scientific research work. Pyrometer Instrument Co., 103 Lafayette St., New York City.

Rubber Coatings. Automotive Rubber Inc., 8601 Epworth Blvd., Detroit, Mich., in their new bulletin describe and illustrate applications for their seamless rubber coatings for production parts. These include equipment for the plating field, such as dipping baskets, plating racks, tanks, anode scrap holders and various articles for general manufacturing.

New Books

Metal Coloring and Finishing. By Hugo Krause. Published by Chemical Publishing Co., New York City. Size 6″ x 9″; 220 pages. Price $5.00.

This book represents an English translation of the standard book by the author published in German.

This volume discusses from the theoretical, practical applications, and patent angles the subject of metal coloring by chemical, mechanical and electrical methods, the latter being sub-divided into cathodic and anodic procedures. The author attempts to relate all the important methods applied to iron and steel and the base and noble metals, in their sheet, cast, mechanically fabricated, or electroplated forms.

The monograph is comprehensive and will be of use as a reference and guide book to those engaged in metal coloring in its decorative as well as protective phases. Many of the so-called secret processes of the electroplating art are described in considerable detail with critical comments by the author. He has accorded American practices considerable attention.

Due to detail in writing and publishing there is, of course, considerable delay and as a result, the book does not consider processes developed since 1937 for the coloring of metals. Nevertheless, most of the basic processes are described, and these methods can be used as a foundation for the development of modified processes.

The index is scant and incomplete, but this deficiency is somewhat offset by detailed contents pages.

This book is a welcome addition to the scant literature on metal coloring.

Chemical Engineering Catalog 1939; 24th annual edition. Published by Reinhold Publishing Corp., New York. Size 8″ x 11″; 1026 pages. Price $3.00; will be loaned free for temporary use.

This book contains collected, condensed and standardized data on equipment, ma-

chinery, laboratory supplies, heavy and fine chemicals and raw materials used in the industries employing chemical processes of manufacture with classified indices of such equipment and materials carefully cross-referenced, and a technical and scientific books section, cataloging and briefly describing a practically complete list of books in English on chemical and related subjects.

Oxy-Acetylene Welding for Beginners. By J. W. Giachino. Published by the Manual Arts Press, Peoria, Ill. Size 6″ x 9″; 96 pages. Price $1.48.

This text was prepared especially for the beginning student of oxy-acetylene welding, and covers the technique from the simplest to the most advanced operations. It contains 24 lessons, each accompanied by a brief, clear explanation of needed apparatus, safeguards, use of tools, and methods of procedure, followed by questions which clinch the information presented in the given lesson. One lesson is devoted to the identification of metals used in welding—a matter of great importance to the welder.

A welding check card enables both the instructor and student to keep an accurate record of the progress being made. The last lesson contains instructions for making 17 projects including andirons, log grate, fireplace screen, service table, smoking stand, etc.

Directory of New England Manufacturers. 1940. Published by George D. Hall, Boston. Size 7½″ x 10½″; 736 pages. Price $20.00.

The book which lists alphabetically nearly 17,000 New England manufacturers together with the names of the chief executives, also includes a description of the products made, the number of employees, location of plants and branch offices.

The companies are also listed geographically under a products listing; brand names and trade marks are also listed alphabetically.

This book which has been published with the editorial cooperation of the New England Council, should be of great value to every executive, sales manager and purchasing agent who either sells to or purchases material from New England manufacturers.

Standard Methods for the Sampling and Analyzing of Aluminum and Certain Aluminum Alloys. Published by Aluminum Research Institute, 308 W. Washington St., Chicago, Ill. Size 11″ x 8½″; 30 pages; paper covered.

A complimentary copy of this edition is available to domestic consumers of aluminum alloys who maintain their own laboratory, to commercial laboratories and technical schools and colleges. A charge of one dollar per copy will be made to others. If a consumer of aluminum does not operate his own laboratory, the Institute will, upon request of such consumer, send a complimentary copy to the commercial chemist who does such consumer's laboratory work.

This is the second edition of an authoritative volume on methods of analysis of aluminum alloys. The methods as recorded are a result of years of study by the Chemists' Committee of the Aluminum Research Institute.

The book contains methods for the determination of chromium, copper, iron, lead, magnesium, calcium, manganese, nickel, silicon, tin, titanium and zinc.

Modern Blast Cleaning and Ventilation. By C. A. Reams. Published by Penton Publishing Co., Cleveland Ohio. Size 6″ x 9″; 208 pages. Price $4.00.

The author, who is an engineer for the power and construction department of the Ford Motor Company, has drawn heavily on the experience and advice of the American manufacturers of blast cleaning equipment and materials.

The book includes a chapter on the development of blast cleaning, followed by chapters on abrasives and various constructional features of blasting equipment.

Extensive detail is rightly given to the ventilation and industrial hazardous aspects of blast cleaning.

The book is of a practical nature and should be of considerable value to all those engaged in the blast cleaning industry.

Catalogue of McGraw-Hill Books. 1939. A catalogue listing books published by McGraw-Hill Book Co., Inc., New York City, on all branches of science and technology.

Errors in Reflectance Measurements of Porcelain Enamel Surfaces. By M. J. Bahnsen and L. S. O'Bannon. Published by the Technical Staff of the Ferro Enamel Corp., Cleveland, Ohio.

Rate of Oxidation of Steels as Determined from Interference Colors of Oxide

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Films. By D. J. McAdam, Jr. and G. W. Geil. RP 1221. National Bureau of Standards, Washington, D. C. Price 10c. Write to Superintendent of Documents, Washington, D. C.

Tensile Elastic Properties of 18:8 Chromium-Nickel Steel as Affected by Plastic Deformation. By D. J. McAdam, Jr. and R. W. Mebs. Report No. 670. National Bureau of Standards, Washington, D. C. Price 15c. Write to Superintendent of Documents, Washington, D. C.

The Theory of Impact Testing: Influence of Temperature, Velocity of Deformation, and Form and Size of Specimen on Work of Deformation. By D. J. McAdam, Jr., and R. W. Clyne. American Society for Testing Materials, Philadelphia, Pa.

Annual Report of Mining Division, Fiscal Year 1939. By Chas. F. Jackson. R. I. 3470. Bureau of Mines, Washington, D. C.

Associations and Societies

American Electroplaters' Society

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BRIDGEPORT BRANCH

The November Educational Session of the Branch was featured by a talk by *Ed. Bucy*, Technical Director of the Zapon Div., Atlas Powder Co., who spoke on "New Developments in Organic Finishing."

Clarence Helmle was Technical Chairman.

George B. Hogaboom will be the guest speaker at the December open meeting.

DETROIT BRANCH

The annual Educational Session and Banquet will take place on December 9th.

The Educational Session will start at 2 p.m. and will be featured by the following speakers:

Dr. Colin G. Fink, Columbia University, New York — "The Electrodeposition of Manganese."

Dr. A. Kenneth Graham, Consultant, Jenkintown, Pa.—"A Discussion of Electrolyte Films."

T. F. Slattery, Bureau of Printing and Engraving, Washington, D. C.—"Electrolytic Processes as Applied to the Production of U. S. Currency, Bonds and Stamps."

The Committee has announced an excellent program for the banquet and advance notices indicate that this meeting will eclipse the huge meetings held in the past.

LOS ANGELES BRANCH

An exceptionally well attended meeting resulted on the night of November 8th from the decision of the Los Angeles Branch, to vary its usual procedure by following the regular monthly business session with an hour or two of relaxation, in the form of games and refreshments.

Attendance was approximately 30, and with President *Ray Bray* in the chair, the business session was handled with the smoothness and dispatch which the chapter has come to expect from the enterprising young man into whose hands it had placed the administrative affairs of the chapter for the current fiscal year.

The Educational Committee, through Librarian *Emmet Holman*, presented as the guest speaker of the evening, *F. H. Kienzle*, representative of the chemical department of Braun Corp., chemical and laboratory supply firm.

Mr. Kienzle read a paper prepared by the Industrial Chemical Sales Div., West Virginia Pulp & Paper Co., New York, entitled "Activated Carbon in Electroplating."

Another paper, submitted by *D. M. Bedwell* as prepared by the Powers Heat Regulating Co., Detroit, dealt with "Automatic Control of Chromium Plating Tanks."

Upon motion by *Frank Rushton*, seconded by *M. D. Rynkofs* (who had started the original discussion), the chapter decided that in the future a small biographical sketch, including name, address and name of firm, of all new members accepted by the Los Angeles Branch, will be prepared for publication in the Monthly Review. Such material, according to Mr. Rynkofs, would be of value to all members in becoming better acquainted with new members, as well as giving the latter deserving advertising upon their entrance into the organization. The motion was made to be retroactive in regard to several new members from Australia recently taken into the branch.

J. Krulik, of the Palace Plating Works, Los Angeles, was accepted as an associate member at the Nov. 8th meeting, but due to the volume of other matters at this session, will not be formally inducted into membership until the December meeting.

DECEMBER, 1939

ORGANIC FINISHING

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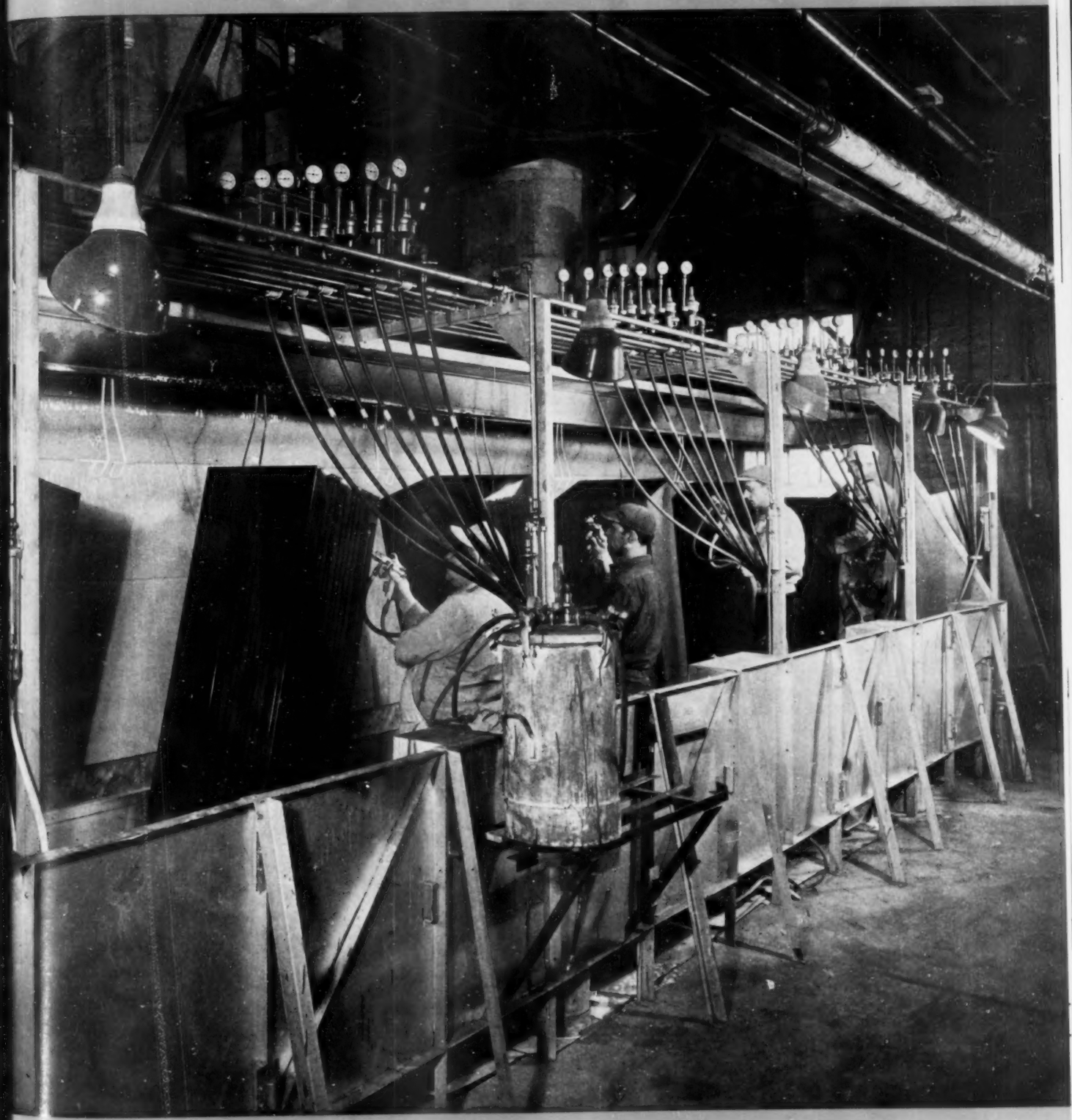

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DECEMBER, 1939

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Oven Fires

Reports on industrial fires indicate that more than half of those occurring in finishing rooms have their origin in baking ovens. Although the immediate causes are listed as over-heating, dirty and defective flues, vapor explosions, ignition of drippings, etc. it is obvious that there is a broader, more essential reason for such fires. Certainly it is not because of poor design or construction practiced by the oven manufacturers. The many installations which have operated over long periods without a single fire attest to this.

The real reason, as a moment's thought will show, is improper operation and maintenance. No changes in the equipment should be made until the manufacturer has been consulted for his advice. This applies particularly in those cases where the temperature of the oven is to be increased. A thorough cleaning to remove all dust, dirt and drippings from the body of the oven and the various ducts should be performed regularly. At the same time, an inspection should be made of the insulating sections to determine if repairs or replacements are necessary. Finally, all accessory equipment, including blowers, burners, control and recording apparatus, etc. should be checked periodically to determine if they are functioning properly.

Any operation in the application of organic finishing materials is dangerous. Not only are lacquers and enamels highly flammable, but the vapors of the solvents used are capable of forming explosive mixtures with air. Since experience has shown that baking ovens are the greatest single fire hazard in the finishing room, it is important that the possibility for fires at that point be reduced to a minimum. This can be accomplished by operating a clean, accurately controlled oven according to the recommendations of the manufacturer.

L. J. LANGDON, *Publisher* • THOMAS A. TRUMBOUR, *Business Manager* • DR. WALTER R. MEYER, *Editor*

Adherence of Organic Coatings to Metals – Part II

By Dr. A. E. Schuh

Director of Research,
United States Pipe and Foundry Co.,
Burlington, N. J.

The author concludes his discussion of adherence of organic coatings. The effects of the chemical state of the surface, are discussed. Structure, permeability and stability of organic coatings are considered at length.—Ed.

Chemical State of the Surface

If the physical contour of a metal surface is fixed, it is then the chemical nature of the surface which determines the adhesion of a given paint. As previously stated, with a well-defined chemical surface, short range forces set the ultimate limit of adhesion that can be realized. Actually, however, the surfaces to which paints are applied are seldom, if ever, sufficiently well-defined for these molecular forces to act as primary controls of adhesion. In practice, the paint technologist is necessarily and justifiably concerned with grosser aspects of the chemistry of these surfaces. Metals are submitted for application of paints which are covered with macroscopic variant films, usually thousands of molecular layers thick. These layers may be rust, mill scale, other surface compounds, water, dirt, greases, etc. The technical problem therefore is to homogenize the surface as well as is economically feasible by various physical and chemical "cleaning" methods and the importance of such cleaning has been well recognized. Whereas a contaminating layer may itself be well wetted by the paint vehicle and thus be quite adherent to the paint, its own cohesive strength or its adhesion to the base metal is as a rule low, and hence the adhesion of the paint film to the metal is low. Thus by lack of cleanliness a weak link is forged into what otherwise might have been a strong chain.

Some recent experiments were conducted to ascertain the degree to which a clean metal surface may be contaminated by oils and greases before the adherence of the organic finish is noticeably reduced. The results, still very preliminary, indicate that a contamination of the order of a few tenths of a milligram of grease per square inch of metal surface affects the adherence of most organic finishes. From an engineering point of view this indicates the need for a high order of cleanliness. However, even this small quantity represents several hundreds of molecular layers of contaminant. Undoubtedly the degree of compatibility of the organic contaminant with components of the finishing medium plays an important part. In other cases, selective adsorption of the contaminant may block off the finish medium. It is well known that many of the modern synthetic baking finishes, owing to restricted compatibility with oils and greases, are more sensitive to such surface contaminations than the older type of oleoresinous baking finishes.

Arthur E. Schuh

Another manner in which the chemical nature of a metal surface influences the adherence of organic finishes is by way of chemical reactions which the base metal can undergo with reactive components in the finish vehicle. This is assuming increasing importance with the wider adoption of new die-cast alloys of such metals as zinc, aluminum, and magnesium. It is quite likely that the initial adherence of organic coatings to clean surfaces of these metals is as high as that obtained with less reactive metals. However, the entry of small quantities of moisture to the metal interface causes difficulties of retaining adherence. The magnesium alloys are particularly difficult in this respect[6] and consequently, chemical pre-treatments are necessary to alter the chemical nature of the surface so that this reactivity is minimized, a dip in a solution containing nitric acid and sodium dichromate having been found effective[7]. Other surface films on magnesium have also been investigated, such as fluorides and selenides. Aluminum offers considerably less difficulty in retaining adherence of organic finishes, owing to the compact structure of its readily formed oxide film. However, Edwards[8] has pointed out variations in its alloys, those containing magnesium showing relatively less stability of adherence. For drastic exposures, a heavy oxide film, such as produced by electrolytic oxidation, is recommended and has proven to develop a permanent anchorage. In order to improve the adherence retention of paints over zinc, a number of treatments have been recommended, such as mechanical surface roughening, weathering

prior to painting, various chemical conversion treatments, and incorporation in the paint of such pigments as zinc dust to compete with the base metal[9, 10].

During the early drying period of oil vehicles, a number of products are split off as a result of oxidation, some of which have been identified as short chain organic acids. In the presence of small amounts of moisture which inevitably diffuse to the substrate, reactions with these active metals can occur. These reaction products are less dense than the metal and are weakly coherent. Wing[11] has identified zinc formate produced during the drying of a linseed oil film when coated on zinc. At the Bell Telephone Laboratories it has been found that thick coatings of long-oil varnishes on brass quickly lost adherence when exposed outdoors but retained it indoors. Thin coats of the same varnishes or even thick coats of varnish containing more resin retained adherence even outdoors[12]. Baking finishes have shown adherence retention on outdoor exposure when the zinc metal was merely sand blasted, and ordinary paints have given very satisfactory adherence retention when the zinc surface was completely converted to a phosphate. However, complete conversion of the entire surface to these less reactive chemical coatings is important.

Although these more reactive base metals have been selected for discussion, it must not be inferred that iron and steel are immune to these interfacial reactions. The life of painted steel is definitely influenced by the composition of the steel and the chemical state of its surface. The Corrosion Committee of the Iron and Steel Institute[13] is finding that painted copper-bearing steels are corroding more slowly in the atmosphere than other painted steels, as has also been observed by Speller[23]. In addition, the importance of complete scale removal is being emphasized in the British studies. It is common practice, where feasible, to convert the iron surface to a phosphate to minimize lateral propagation of rust beneath a paint coating. Special priming paints are widely used. These paints usually contain pigments which prevent or minimize anodic attack of the metal by virtue of their slight alkaline nature or slightly-soluble chromate content. By such measures rust formation or propagation with its attendant destruction of adherence is either prevented or effectively delayed.

Composition, Structure, and Aging of the Coatings

Factors inherently related to the composition of these organic coatings affect their adhesion to metals in several ways. Some affect the initial adherence, whereas others are more related to the retention of adherence.

With respect to initial adherence, most finishing materials, for purpose of application, require solvents as a means of dispersing the permanent constituents. These solvents furnish the required mobility to these constituents of the film to make possible the development of adhesional bonds. In nitrocellulose lacquers particularly, proper solvent combinations are essential for the laying down of continuous adherent films. A number of finishing materials, particularly those containing cellulose derivatives, undergo serious shrinkage as the last part of the solvent escapes. It has been shown[14] that nitrocellulose lacquers contain as much as 10 to 15 per cent of the original solvents at the dry-to-touch stage. In these lacquers and enamels, plasticizers and resins find use not only as a means of providing additional anchorable constituents, but also to provide internal cushioning to counteract shrinkage effects as solvent escapes. A resin-free cellulose acetate film, even though plasticized, when deposited from solution shrinks to such an extent that it will pull itself off spontaneously from almost any dense surface. However, when hot pressed from a dry sheet of acetate of the same composition, the film does not shrink nearly so much and in thin layers can adhere over various surfaces where the same thickness laid down from solution would peel. Similarly, a solution of ethyl cellulose deposits a film of poor adherence on a smooth metal surface; yet, when hot pressed in a dry state a high adhesional bond is developed between smooth metal surfaces.

Permeability

Certain finishing materials, such as drying oils and varnishes, vary considerably in their acidity and hence in combination with certain metals and moisture promote the development of interfacial reaction products which destroy adhesion. The permeability of moisture through organic finish films varies over a wide range depending on the composition and formulation of the finishing medium. A low moisture permeability is important even though the complete exclusion of moisture from the metal-finish interface is beyond the range of practical possibility. This is so because a film of low permeability will retard the entrance of moisture sufficiently to prevent establishment of equilibrium with the external atmosphere during limited periods of high humidity. Reactions at metal surfaces in general exhibit a sharp acceleration in rate at relative humidities of 70 per cent or higher. These accelerations are largely avoided by the use of low permeability coatings.

The following table lists the initial permeability to moisture of a number of finishes.. The coatings were deposited at a thickness of 0.001 in. on cellophane and their permeability was determined one month after application, by measuring the transfusion of water vapor at a differential humidity of 90 per cent and constant temperature (25° C.).

Permeability of Moisture Through Organic Coatings

	Milligrams of Water per 0.001-in. Film per Square Inch in 24 hr.
Cellophane (not moisture proof)	300
Cellulose acetate	300
Vinyl acetate	115
Vinyl chlor acetate	27
Linseed oil	80
Long oil varnishes	36 to 48
Long oil varnish plus aluminum powder	14
Short oil varnishes	17 to 24
Single-pigment paints	29 to 56
Nitrocellulose lacquers	15 to 87
Orange shellac	16
Asphaltic coating	5

The wide range of initial values shown in the table is of significance primarily in those cases where a high order of reactivity with the base metal prevails. In more normal cases, the change in permeability with age becomes increasingly important. Most finishing materials gain in moisture impedance on aging up to the point where intrinsic film failures, such as checking, cracking, etc., begin to appear, at which point a ready entrance to moisture may be provided, depending on the number and depth of the cracks developed. The speed at which

such intrinsic film defects appear is governed by the composition of the film-forming material, that is, vehicle plus pigment, and the nature of the exposure environment.

Structure and Stability

The composition of the coating material affects adhesion in another manner. Different finishing materials develop coatings of widely differing structure and attendant physical behavior. Some are tough, that is, both strong and distensible, others non-distensible but high in tensile strength, and still others highly distensible but weak. These structural characteristics affect the adherence of the coatings in several ways. In some instances, shrinkage stresses within the coatings may grow to the point where they can overcome adhesion. In others, the apparent loss of adherence may really be attributable to a coherence failure close to the substrate, owing to the low tensile strength or else the brittleness of the coating. Even though it may be questionable to classify this as an adherence failure, from a broader practical point of view such a classification appears justifiable, since with a material of this type the metal base may be readily laid bare to the eye by even the mildest external force. Whether there still remains an exceedingly thin film of the coating over the metal has little practical significance. On aging, many organic coatings fail in just this manner.

For purpose of gaining more insight into this question of structure, a number of different types of finishing materials have been subjected to stress-strain analyses of their free and adherent films. In free film studies, admirably conducted by Nelson and his coworkers[1, 2, 3], a detached film specimen is subjected to tension under controlled conditions. The load required to stretch the film and the amount of stretch are recorded up to the point of rupture of the film. The stress-strain curves thus obtained are highly informative with respect to the strength of the film, effect of pigmentation, type of flow, effect of environment, etc. By relating such curves to composition of the coating materials and repeating the tests at periodic intervals, a comprehensive understanding of film structure and aging effects is obtained. However, no information with respect to adhesion and its effect on the film characteristics is furnished by the free film method. This has been overcome to a large extent at the Bell Telephone Laboratories by performing various physical tests on the actual finished specimens, that is, with films adherent to the metals[15, 16, 17]. Distensibility is determined either by direct extension of the finished specimen until film cracking occurs, or by bending around suitable mandrels and calculating the film stretch at the mandrel radius at which first cracking occurred[18, 19]. The relative film strength is determined by an abrasion test developed at the Bell Telephone Laboratories[20]. In this test, an abrasive-air stream (180 mesh carborundum — 10-cm. mercury air pressure) is allowed to impinge against the surface of the finish, suitably positioned, until the base metal is revealed. The required amount of abrasive is determined and with known film thickness, an abrasion value, in terms of grams of abrasive per 0.001 in. of coating, is obtained. In this test a relative measure of the cohesive strength of the coating is obtained. The abrasion value in effect integrates the area under a stress-strain curve of the detached film. Hence, on dividing the abrasion value by the experimentally determined distensibility of the anchored film, an approximation of the relative, effective tensile strength of the coating is obtained. Just as it is found in free film stress-strain analyses that aging is accompanied by reduction in elongation and increase, frequently followed by decrease, of tensile strength of many finish films, so in testing anchored specimens are similar changes with age revealed. In addition, changes in adherence are measured by noting the velocity of impact of a rotating hammer[21] as it strikes the paint coating and removes it from its base metal.

By means of such physical analyses, the various types of organic finishes can be investigated and relations with their adherence properties shown. Thus, linseed oil paint films show in their early age very high distensibility and low tensile strength. The flow is elastic over a wide range of elongation, coatings stretched over 60 per cent of this length having been found after rupture to return to their original length. On aging, that is, on progressive densification of the gel structure, the film gains strength and loses distensibility. As the climatic factors such as sunlight, rain and temperature changes further age the film, it degrades and disintegrates from the outer surface inward, gradually losing both tensile strength and distensibility. Both these aging processes are accompanied by effects on adherence. Initially, with clean surfaces, the adherence is excellent and much greater than the cohesional strength of the film. During early aging, the anchored film develops increasing shrinkage stresses. The magnitude of these stresses is largely determined by the thickness of the coatings. The flaking and peeling of large pieces of paint from structures that have been repeatedly coated is generally familiar. In the later stages of aging, film degradation proceeds to the point where checking and cracking develop and frequently only a mild external disturbance (impact, thermal stresses, etc.) may be required to remove most or all of the coating from the base material. As might be expected, pigmentation of the oil film plays a most important part in these aging phenomena. However, it is beyond the scope of this paper to enter a discussion of pigmentation.

The shrinkage stresses that develop in many organic coatings do not really affect the specific adhesion of the coatings to the base metal, but set up forces opposing adhesion to the point where they become larger than the adhesional forces. A thin coating of gelatin on clean glass adheres well over a wide range of humidity. A thick coating, on the other hand, on drying soon sets up stresses sufficient to pull itself off the glass. The interesting effect is that often at the moment of severing from the glass, the adhesion to the glass is high enough to pull glass away with it, showing that the adhesion was higher than the cohesion of the glass. The phenomenon has actually been commercially exploited to produce a decorative frosted effect on glass.

Certain lacquer coatings have exhibited a similar behavior[17]. Metal foils covered with them coil into tight spirals as the lacquer coating dries and ages. A thick film of a certain lacquer was found on early aging to bow appreciably a copper panel $\frac{1}{32}$ in. thick. The adhesion must have been very high to bring this about. On outdoor exposure, this material[12], when applied more than 0.002 in. thick, spontaneously split off large pieces of coating after only three months. However, the remaining adherent sections of the coating on the

test panels withstood the impact of a revolving hammer at 2000 r.p.m. without loosening. A thinner coating (0.001 in.) of the same material is still adherent and in excellent condition after four years on the roof.

A further illustration of these opposing shrinkage stresses is shown in a recent experience with an adhesive joint between two polished steel surfaces. The cementing material was a thermoplastic molding compound. When used as a molding compound, the plastic on cooling parted spontaneously from the mold surface with an unmarred lustrous surface, as would be expected from a satisfactory molding compound. The same dry material, however, when squeezed between two polished steel surfaces into a thin layer, under conditions of heat and pressure comparable to those used in molding, gave a joint strength in tension of about 1000 lb. per sq. in. The explanation for this phenomenon lies in the fact that in a thin layer the shrinkage stresses on cooling were far from sufficient to overcome the adhesion to the smooth metal surface. The same material, when squeezed into a thin layer against finely-roughened steel surfaces, gave a joint strength in tension of 6000 lb. per sq. in., approximating the cohesive strength of the plastic itself.

Shellac is another organic coating material which in thermoplastic joining of metals has given joint strengths in tension of about 2 tons per sq. in.[22]. However, shellac as a coating material for metals gives a poor account of itself. Its impact and wear resistance are very low. A stress-strain analysis of the material provides the answer. The material exhibits very little distensibility and hence is quite brittle. Even a mild external force is sufficient to shatter the coating and expose the base metal near the point of impact.

Varnishes, depending on the amount of resin incorporated in the heat-bodied drying oil, may act either similar to a drying-oil film or at the other end of the scale like a shellac film. As the amount of resin is increased the material progressively loses distensibility. The abrasion value of a short-oil ester gum varnish (a typical furniture varnish) is usually less than 10 g. per 0.001 in. of coating. Its distensibility is less than 3 per cent. A long-oil varnish, on the other hand, usually shows abrasion values of greater than 50 g. and an elongation of greater than 60 per cent. On exposure, the short-oil material shows cracking and peeling within a few months. Even a mild scuffing then removes it from the base. The long-oil material, on the other hand, usually shows excellent adhesion for a long time. Varnishes compounded with modern synthetic resins are not so sensitive to embrittlement as those made with the older types of varnish resins.

Baked finishes in general form strong tough films with a high level of adherence to the base metal. The process of baking definitely increases the strength of bond to the substrate. The baked coatings, being both tough and adherent, are removed mechanically only with difficulty. Round-headed nails finished with certain baking enamels have been driven into pieces of hard oak wood without disrupting the finish[21]. With increasing coating thickness, shrinkage stresses during baking and subsequent aging are developed at times, which may grow sufficiently to pull off the coating from its base.

Conclusion

It is hoped that this survey of several types of organic coatings on metals will have served to indicate the complexity of interrelated factors that influence the adherence of such coatings. It is only in rare cases, usually those of gross negligence, as in improper cleaning, use of excess finish, etc., that a single simple cause may explain a given case of poor adherence. In most other cases, faulty adherence is attributable to complicated causes which frequently are not related to the initial strength of adhesional bond. The coating material may have degraded to such a point of weakness and brittleness that a slight impact or other external stress causes it to fall off. In other instances, a new and weakly-coherent interface may have developed as a result of high moisture permeability and thus destroyed the adherence of the finish. Finally, with thick coatings, sufficient internal stresses may have developed in certain coatings that even the best adhesional bond is overcome and as a result poor adherence of the finish produced.

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Rust Proofing and Finishing of Unit Heater Casings and Convector Enclosures

By C. T. Perkins

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Modine Manufacturing Co.,
Racine, Wisconsin

The author describes tests made on rust proofing processes and a modern plant for rust proofing and finishing.—Ed.

The growth of American industry is largely due to the spirit of pioneering, —that indomitable will to succeed, no matter what the cost or what the obstacles in the way. Research and experimentation have played an important part in much of this climb to success. In the unit heater field we find one such pioneer in the Modine Manufacturing Company, at Racine, Wisconsin, who nearly seventeen years ago brought out the suspended type unit heater for industrial and commercial use. More recently other products were added, among which are convectors for the home and office. The company's latest pioneering step is in making unit heaters and convector enclosures available with a durable finish protected against rust intrusion.

Unit heaters installed in industrial plants are frequently exposed to moisture as well as corrosive fumes resulting from various manufacturing processes. In such an atmosphere, paint alone is not a protection against rust and therefore is not sufficiently durable as a finish. Convectors too are subject to rust invasion, perhaps through an insignificant scratch or nick caused by furniture contact or floor cleaning implements, or perhaps by children's toys. Rust, even though a tiny scratch to start with, will spread and undermine the finish and cause serious deterioration, unless the metal has previously been treated and given a rust-protecting armor. The salt air in sea coast points likewise has a detrimental effect on unprotected unit heaters and convector enclosure installations.

Experimentation to Solve this Problem

There are two major reasons why paint finishes fail,—lack of adhesion of paint to the metal surfaces, and corrosion of the underlying metal, due to penetration of moisture through the paint film. In seeking a protective

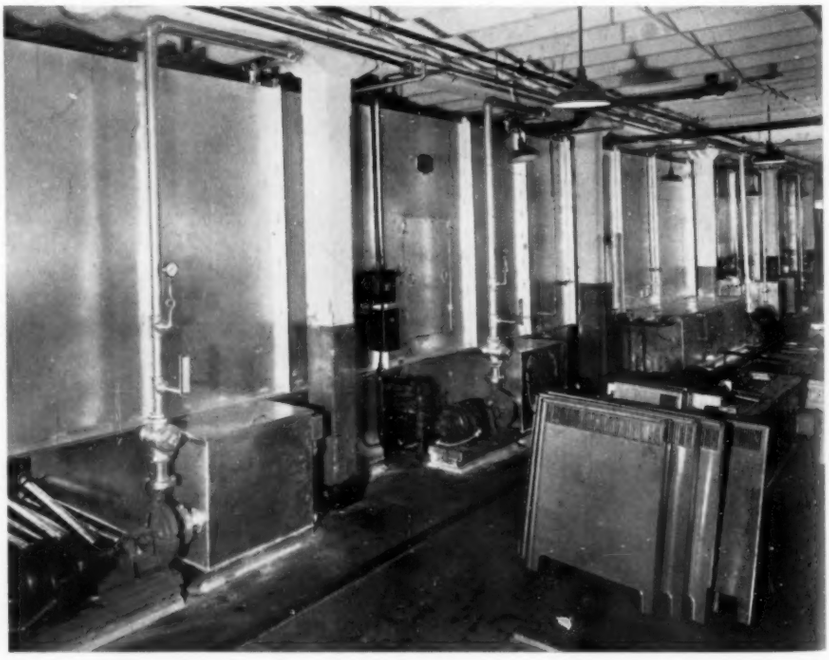

Fig. 1. Bonderizing equipment showing enclosed cleaning, Bonderizing and rinsing chambers. The pumping and driving equipment is located outside.

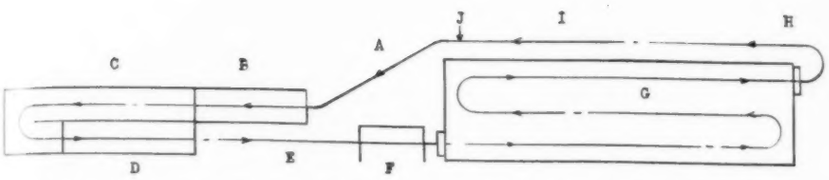

Fig. 2. General arrangements of ovens, Bonderite system and spray booth. (A) loading zone; (B) metal parts washer; (C) Bonderizing system; (D) dry-off oven; (E) cooling zone; (F) spray booth; (G) paint baking oven; (H) cooling zone; (I) unloading zone; (J) center line of conveyor.

finish for its products, Modine Manufacturing Company devoted considerable time and effort to making numerous practical tests to determine the finish best suited for its products and to overcome the possible invasion of rust. Experiments showed that a treatment is required that seals the metal pores against moisture, and assures a better paint adhesion, if the final finish of a product is to maintain its good appearance over a long period of time.

Test panels were made and given a variety of treatments, after which some were water-soaked, others were subjected for many days to a salt spray, still others were exposed to sun and salt air of a sub-tropical climate, while still others were hung in a room where a constant humidity was maintained. The results of these tests were recorded and analyzed. Not only did these tests demonstrate the quality of the paint used, but also showed how important it is to start with a proper base and process the metal surface, prior to painting, so as to obtain a non-metallic chemically inert coating which would increase and insure adhesion and also arrest and prevent the formation of rust. Bonderizing was the method decided upon to furnish this coating. Having come to this decision, proper equipment was installed.

The System and Sequence of Operations

As a base, hot rolled, pickled, oiled and stretcher leveled steel sheets are used in the manufacture of convector enclosures, and cold rolled drawing quality on unit heater parts. Because of the great variety of sizes, all convectors are made to order, using a special production line of single purpose machines to expedite deliveries. In ordering from the steel producers, specification is made that the sheets must be delivered suitable for Bonderizing treatment. Operations in the plant are straight line production. The work passes from the shears, cutting machines, and punch presses to the welders, where some of the parts are spot-welded, using gun and floor welding machines, and others are riveted.

As the welders finish their operations they have merely to hang the parts on "Christmas tree" hangers suspended from the hooks of a trolley conveyor as it passes along at the end of their work tables. This continuous trolley conveyor, 750 feet long, consisting of two-wheel ball-bearing dirt-proof trolleys, spaced approximately at 32-in. centers, and rolling on an I-beam, carries the work directly into a long enclosed tunnel.

As the work moves along on the conveyor line through the varied steps of cleaning, Bonderizing, and rinsing, in each chamber it passes a series of standpipes with spray nozzles through which the water or solution—depending upon the chamber through which the work is passing—is forced against the material from every angle, reaching all areas to be treated. There are reservoirs below where the solution is collected ready for recirculation.

In this tunnel, the pieces first pass through a 3-stage washer chamber,—the first stage being a hot (180°F.) emulsion cleaner section with a pump having a capacity of 500 g.p.m. The second stage consists of a hot water (180°F.) rinse chamber with a 300 g.p.m. pump; while the third state is a repetition of the second. Each stage has water-heating coils, suction screens, and boxes, inside the spray heads, and piping, outside manifold piping, splash shields and subway grating. After the second hot water rinse, the parts pass through the Spra-Bonderite section, which is divided into three stages,—one for spraying Bonderite, one for cold water rinse, and one for chromic acid rinse. The Bonderite solution is sprayed onto the parts by means of a stainless steel pump with a capacity of 200 g.p.m., at a temperature of 190°F. while the cold water rinse and chromic acid rinse are sprayed at a temperature of 70°F. and 145°F. respectively, by means of individual pumps with capacities of 150 g.p.m. All rinsers and nozzles, and screens on the section box in the Bonderite chamber are of stainless steel, whereas similar equipment in the other two stages is standard. Water temperatures are obtained and automatically controlled by means of immersed steam heating coils connected to automatic temperature control valves.

On leaving the chromic acid spray chamber, the conveyor makes a hairpin turn, carrying the parts for a fifteen-minute trip through a dry-off oven, heated to a temperature of 250° to 275°F. Having passed through this

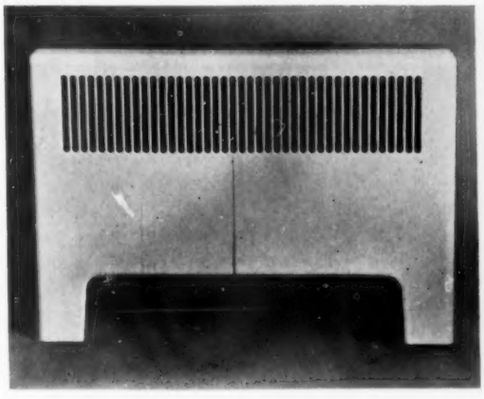

Fig. 3. Note good condition of Bonderized enameled convector enclosure after it was scratched and subjected to 913 hours of salt spray.

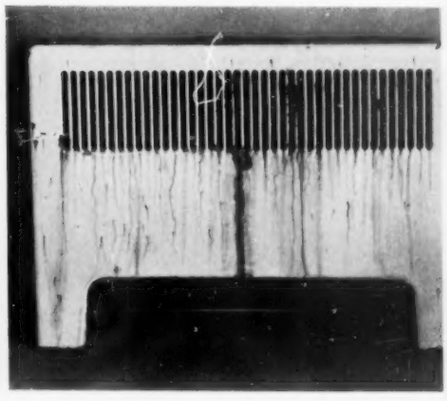

Fig. 4. Note poor condition of same co vector enclosure as in Fig. 3, except t Bonderizing treatment was given t metal.

cleaning and chemical process, the metal surfaces have been changed to a non-metallic phosphate coating composed of millions of microscopic crystals, integral with the metal. The paint next to be applied, after the metal parts have been brought down to room temperature, flows into the interstices around the crystals, and as it dries forms a locked cohesive union with the phosphate coating which, being in fact a part of the metal surface, results in perfect surface adhesion and seal.

Spray Painting and Baking Operations

The work at this plant is so scheduled that jobs requiring only a prime coat and those to be given a prime as well as a synthetic enamel finish coat are put through the cleaning and finishing processes at different times. All convector enclosures receive only the prime coat, while the unit heater casings are given a first and also a finish coat.

As the work comes from the dry-off oven, if two-coat jobs are being put through, they are tack ragged as they pass along towards the two-man paint spray booth. This booth is of the water wash type, and the paint is supplied through a "dead-end" system from 60-gal. air pressure tanks situated on the floor below, directly beneath the booth. Only three colors, (brown, black, and blue) are used with this pressure system. Other colors, such as red, white, or any others indicated by specification, are conveyed to the booth by gravity from overhead containers. Brown is the color generally used for prime coating.

From the spray booth the conveyor carries the work directly into a 3-pass paint baking oven heated to 275°F. The traveling time within the oven varies according to the requirements, the power-driven conveyor chain being equipped with a variable speed drive unit so that the speed may be set at any point between 3 and 9 f.p.m.

The paint baking oven is heated by steam, using standard Modine Blast Heaters, of which there are three, mounted on top of the oven and in an enclosed duct. The hot air passes from the top of the oven into the return duct, through the blast heaters, and is discharged into the bottom of the oven, forming a complete hot air recirculating system. A similar system is used in the dry-off oven. The rings forming the concentric wire fan guards, and other small parts are dipped in the synthetic enamel instead of being sprayed, and are then sent through the baking oven. After leaving the oven, all pieces pass through a cooling zone, and the parts making up the unit heater casings, before they are sent to the assembly bench, are given on their entire inner surfaces a coating of acoustical mastic—a water-asphalt emulsion with fiber aggregate—for sound proofing, which deadens any noises from within. For this work a spray gun is used.

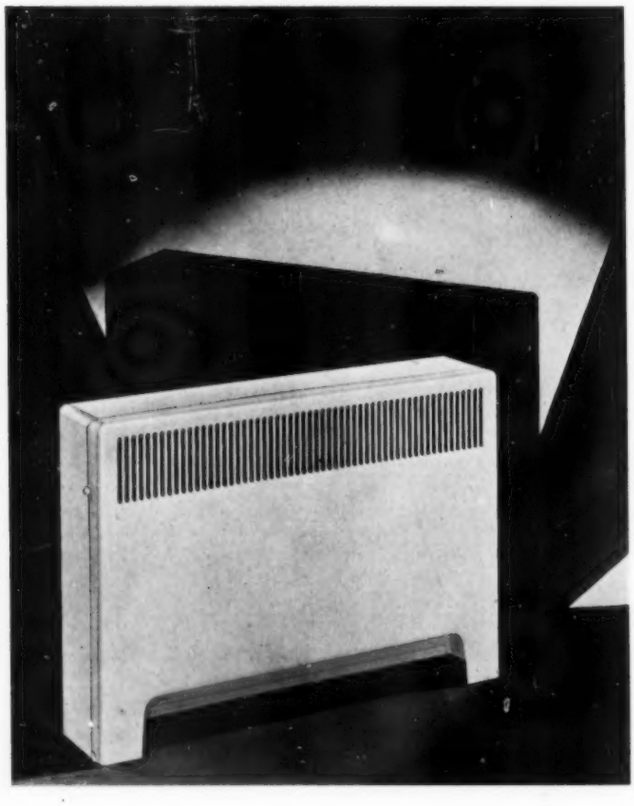

Fig. 5. Standard floor cabinet convector which has been Bonderized and enameled.

Fig. 6. Sticker applied by Modine to all Bonderized products.

Adherence of Organic Coatings to Metals

(Concluded from page 601)

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Surface Treatment of Magnesium Alloys – Conclusion

By Leo Grant

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In the concluding part of this article, treatment #8, the alkaline dichromate treatment is described. Chemical coloring, metal spraying and painting materials are also described.—Ed.

The hydrofluoric acid bath is depleted very slowly in use. It should not be allowed to go below 10% HF as determined by a titration for free acid with normal NaOH and phenolphthalein indicator. Hydrofluoric acid should be added to the bath as needed to maintain the titration between 10 and 20 cc. of N/1 NaOH per 2 cc. of sample. This corresponds approximately to 10 and 20% HF by weight. A pipette for obtaining a bath sample may be made by lining a small (3 or 4 cc.) glass pipette with paraffin wax and calibrating to a 2 cc. volume. To avoid error by reaction of the HF with glass, the sample should be discharged into at least 100 cc. of distilled water in the vessel used for titration and titration should be done immediately.

The 10% sodium dichromate solution will treat the equivalent of 20 full tank loads of magnesium alloys at which time depletion will be indicated by non-uniformity of the coating, or increase in time required to secure a uniform coating. The pH of the solution will now be approximately 6.2. Revivification can be made by adding 1.3% chromic acid (CrO_3), bringing the pH to about 4.2.

More accurate control can be obtained by maintaining the pH between 4.5 and 5.5 with chromic acid, conveniently added as a 10% solution.

Properly applied coatings will vary from dark brown to black. Time of treatment, condition of bath, and alloy composition will influence color of coating.

Lead tanks may be used for containing the hydrofluoric acid bath. Iron tanks lined with a commercial organic lining (name on request) have also been used satisfactorily.

The boiling sodium dichromate solution can be used in iron, aluminum, or almost any of the commonly used tank materials. A loosely fitting lid may be used to minimize evaporation.

Treatment No. 7 as described above corresponds to U. S. Army Specification 98-20010-A paragraph E-3B. It is also tentatively accepted as an alternate for the anodizing treatment covered by Navy Aeronautical Specification PT-13.

Treatment No. 8

This treatment is an improved modification of treatment No. 3, also commonly known as the Alkaline Dichromate.

Treatment No. 8 is almost as protective against salt water as treatment No. 7, while the coating formed is somewhat harder and more abrasion resistant.

Like treatment No. 7, treatment No. 8 effects no dimensional changes on magnesium alloys and may be used on machined parts. Non-magnesium inserts of brass, bronze, and steel are unaffected during this treatment, but aluminum or cadmium plate is rapidly attacked during the hydrofluoric acid dip.

Treatment No. 8 consists essentially of three steps applied as follows after proper cleaning:

1. Immerse magnesium alloys parts for 5 minutes in a water solution containing 15 to 20% by weight of hydrofluoric acid (HF) at room temperature. A satisfactory bath can be prepared by diluting one volume of technical grade 48 to 52% HF with two volumes of water. Wash thoroughly in cold running water.

2. Boil parts for at least 45 minutes in a water solution containing the following ingredients (technical grades are satisfactory):

Ammonium sulphate $(NH_4)_2SO_4$	3.0%	(4 oz./gal.)
Sodium dichromate $Na_2Cr_2O_7.2H_2O$	3.0%	(4 oz./gal.)
Ammonia (Sp. Gr. 0.880)	0.25%	(⅓ fl. oz./gal.)

The original solution level shall be maintained by additions of water to replace that lost by evaporation. Wash parts thoroughly in cold running water.

3. Boil for at least 5 minutes in water solution containing 1% by weight of arsenous oxide (As_2O_3). This solution can be readily prepared by adding technical arsenous oxide to water in the ratio of 1 ounce per gallon. The original solution level shall be maintained by additions of water to replace that lost by evaporation. Rinse parts thoroughly in cold running water followed by a dip in hot water to facilitate drying.

The hydrofluoric acid bath is depleted very slowly in use. It should not be allowed to go below 10% HF as determined by a titration for free acid with normal NaOH and phenolphthalein indicator. Hydrofluoric acid should be added to the bath as needed to maintain the titration between 10 and 20 cc. of N/1 NaOH per 2 cc. of sample. This corresponds approximately to 10 and 20% HF by weight.

The arsenous oxide bath is depleted very slowly and due to its low cost it is suggested that it be renewed monthly during use rather than to attempt control.

The sulphate-dichromate-ammonia solution will treat the equivalent of about 10 full tank loads of magnesium alloys, at which time depletion will be indicated by non-uniformity of the coating, or increase in time required to secure a uniform coating. The pH of the solution will now be approximately 6.2. Control may be accomplished by maintaining the pH between 5.6 and 6.2 with additions of a solution containing 5% by weight each of chromic acid (CrO_3) and concentrated sulfuric acid (H_2SO_4).

Properly applied coatings will vary from dark gray to black. Time of treatment, condition of bath, and alloy composition will influence color of coating.

Lead tanks may be used for containing the hydrofluoric acid bath. Iron tanks lined with a commercial organic lining, have also been used satisfactorily.

The boiling sulphate-dichromate-ammonia solution, as well as the boiling arsenous oxide solution, can be used in iron, aluminum, or almost any of the commonly used tank materials. A loosely fitting lid may be used to minimize evaporation.

Treatment No. 8 as described above corresponds to Navy Aeronautical Specification M-382 and is acceptable as an alternate for anodic treatment PT-13. It is also acceptable on request as an alternate for treatment No. 7 covered by U. S. Army Specification 93-20010-A paragraph E-3B.

Anodic Treatment (Navy Aeronautical Specification PT-13)

This treatment is a government development designed to provide a protective and paint base coating on magnesium alloys for naval aircraft use. Operation details of the process are given in Navy Aeronautical Specification PT-13.

Chemical Coloring

Magnesium alloys can be provided with an attractive, dense, protective finish by a process known as treatment No. 6. The coating possesses better abrasion resistance than any other chemical finish used on magnesium alloys. It is especially useful for parts requiring protective or decorative finishes, but where painting is out of the question.

Treatment No. 6 is applied in an autoclave at temperatures up to 400°F and pressures up to 225 lb. per sq. in. The coating produced will be light gray to bronze in color, depending upon alloy composition. By means of organic dyes, it is possible to provide the coatings with a large variety of colors. Full details for the application of treatment No. 6 to magnesium alloys will be furnished by The Dow Chemical Co. upon request.

Decorative effects can be produced on magnesium alloys by certain other chemical means. Matte to bright silvery finishes are obtained by pickling in sulfuric, acetic, or nitric acid; the degree of luster being dependent both on the strength of acid employed and the original smoothness of the metal surface. Attractive iridescent coatings in a range of shades and lusters are produced by treatment No. 1. The colors obtained by treatment No. 7 or 8 also serve for decorative purposes. While these finishes lack the abrasion resistance of those produced by treatment No. 6, their durability can be improved by coating with clear lacquer or similar material.

Electroplating

Some success has been attained in the experimental electroplating of magnesium alloys. Coatings applied by this method offer the possibility of bright, non-tarnishing finishes for indoor service. Although production methods have not been fully worked out, parties interested in the subject are requested to communicate with The Dow Chemical Company.

Metal Spraying

Sprayed metal coatings may be applied to magnesium alloys for certain applications requiring resistance to abrasion or wear and not subject to high humidity or marine atmospheres. Except in considerable thickness, sprayed metal coatings on magnesium alloys cannot be considered as protective against corrosion and may be the opposite under certain conditions. The use of paint over sprayed metal coatings may permit their use in services not otherwise practical. All sprayed metal applications should be tested under actual operating conditions before final adoption of the method.

Painting

Proper surface preparation and the choice of priming materials are the factors that influence the satisfactory painting of magnesium alloys. Most common paint troubles have their beginning at the point of contact between the primer and the metal surface. Finish coats, it is true, must also be chosen with care, but a greater variety of materials are available. It is well to determine the suitability of both primers and finishes by actual test before using them commercially.

Painting Materials

The choice of painting materials for magnesium alloys is influenced by three conditions of service exposure as follows:

1. Indoor.
2. Outdoor.
3. Marine atmosphere.

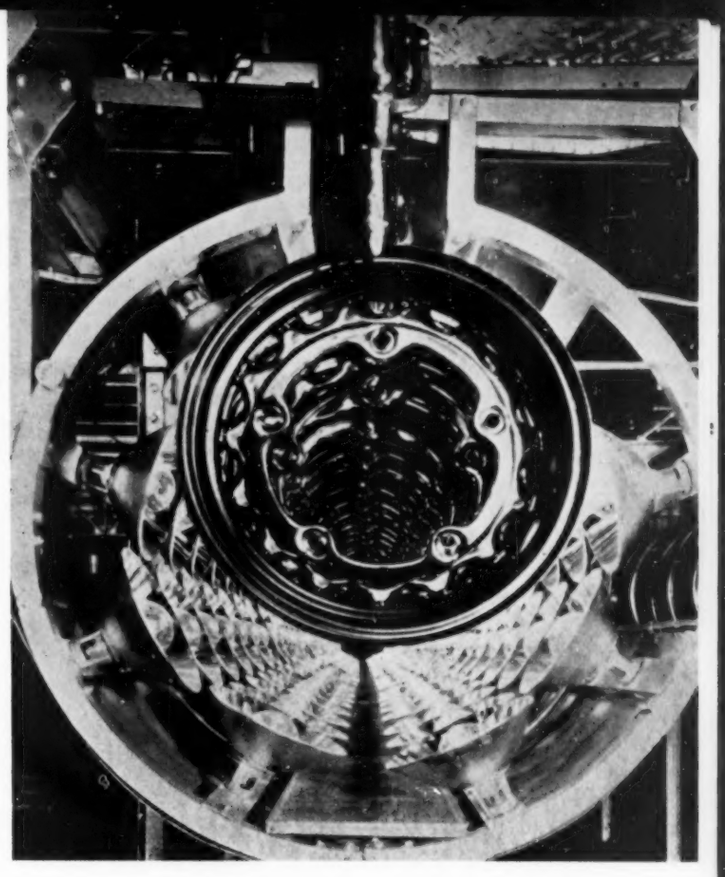
Primers—Care must be exercised in the selection of a primer, especially in regard to adhesion, which is best determined by exposure tests on magnesium alloy panels. Primers for exposure to marine atmospheres should possess, in addition to adhesion, inhibitive character which is best obtained with zinc chromate pigment.

Surfaces — On magnesium alloys parts where a smooth high gloss finish is desired such as on truck bodies, die cast products, and other applications, it may be necessary to use a surfacer. Because surfacers tend to induce brittleness, however, it is well to avoid them when sufficient smoothness can be obtained by simply sanding between regular finish coats.

Finishes—The choice of finish coats to be used in systems on magnesium alloys is largely dependent upon the service conditions to be encountered. Almost any good quality oil paint, for instance, can be used over a recommended primer for indoor service where wear resistance is not required. Full synthetic and oil-base synthetic enamels have proved satisfactory for general exterior work. Materials of this type based on water-resistant resins, such as phenol formaldehyde, are good for marine exposure.

Clear synthetic resin varnishes to which aluminum pigment is added give very good protection and provide attractive finish coats.

Lacquer type coatings are useful for interior service, but must be used judiciously for exterior applications.



A 30-foot lamp "oven" for drying 2000 enameled wheels every 8 hours.

Radiant Energy* Drying with Heat Lamps

By T. P. Brown and L. S. Ickis, Jr.

General Electric Co.

Data are given on reflectance values of metals in the wave-lengths of heat energy. Electrolytic gold has better infra-red reflectance than aluminum or chromium. Reflectors for proper energy distribution are described.

Lamp baking is said to promote more rapid drying of lacquers and enamels than oven baking. They are particularly recommended for "spot" baking and for continuous cycles where insulation on oven ends is difficult.—Ed.

Use of radiant energy for drying purposes dates back to the far-off time when man first set something in the sun to dry. Now electrically produced radiant energy is finding many industrial applications.

Although laboratory tests do not indicate an appreciable difference in drying results between an incandescent source of relatively low color temperature (1500° K) and a comparable incandescent source of relatively high color temperature (3000° K) certain factors in the application of incandescent devices to industrial processes tend to dictate a source temperature which will not at the same time introduce a factor of glare from the light emitted by the closely grouped radiant energy sources. Since the amount of light emitted by the source is in no way an indication of its practicability for radiant energy drying, the factors which dictate the economics of light sources or lamps do not necessarily dictate the economics of heating devices.

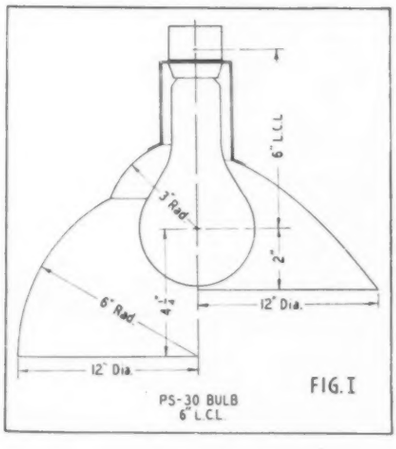


Fig. 1. Diagram of reflectors for use with heat lamps.

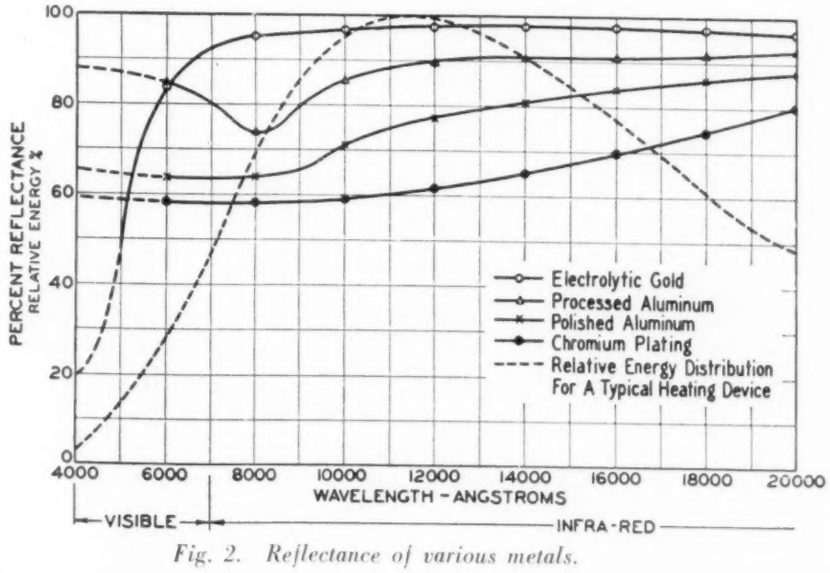


Fig. 2. Reflectance of various metals.

Reprinted from Electrified Industry, Dec., 1938

At the present time incandescent filament sources used for industrial drying consume in the neighborhood of 250-watts, operating at 115 volts. These devices are no larger than the standard 200-watt incandescent lamp. The filaments are operated at an abnormally low temperature to avoid producing great quantities of unnecessary visible radiation and to prolong the life of the device.

Concentrating-type reflectors are used to direct the radiant energy to the surface to be dried. Since the devices are usually mounted over a conveyor carrying the product, there is no "spottiness" in drying with the separate beams from the concentrating reflectors. The necessary concentration can be produced by reflectors which are essentially parabolic in shape as shown on the right half of Fig. 1. An alternative arrangement shown on the left half of Fig. 1 is composed of a series of spherical sections positioned in such a way as to concentrate the major portion of the energy. The simple parabola (right) is more inexpensive, while the combination of spherical surfaces will redirect a larger percentage of the radiant energy for a given diameter.

The surface of the reflectors should be highly polished, easy to maintain, and resistive to corrosion by the gases which are apt to be present in the locality of the lamp bank where paints, lacquers, etc., are being dried. As indicated in Fig. 2 the electrolytic gold and processed aluminum reflecting surfaces are very efficient in reflecting the radiant energy produced by the incandescent filament.

In most cases, the reflectors should be placed in banks very close together with the lamps positioned anywhere from 9 inches to 18 inches from the work, depending on the product undergoing treatment.

Reports from the industries which have pioneered the use of this new drying process indicate that synthetic enamels can be dried in about 10% of the time required by the usual methods and that quick-drying lacquers can be dried in from 5% to 15% of the usual time required. With other types of finishes such as ink, oil paint, varnishes, and dyes, corresponding success is reported.

Although space does not permit a detailed description of the many installations now in existence, users of quick-drying lacquers whose products previously required from 10 to 15 minutes exposure, report a decrease in time required to only one-half to two minutes under the radiant energy sources. Articles finished in synthetic enamel which normally require from 45 minutes to one hour under the usual oven drying methods can, it is reported, now be dried in from five to ten minutes. Enamels which usually require one and one-half to three hours to dry have been dried by this method in fifteen to thirty minutes.

Aside from the many industries whose products have heretofore been finished with a lacquer or a similar finish, there are many other applications of this effective drying method. By the careful application of the radiant energy, certain fast drying inks have been dried in approximately 2% of the time required to dry in air; cardboard and paper of various thicknesses can be freed from moisture in much less time than previously required. Blueprints, photographic prints, tracings, posters, metal parts, resins,—literally thousands of industrial processes lend themselves to the application of radiant energy drying.

Organic Finishing Digest

Primer Adhesion. S. Marks. Paint Manufacture. August 1939. If a coating of paint or lacquer is to perform any decorative or protective service it must first of all adhere to the surface for which it is intended and it must adhere tenaciously. The mechanism of adhesion between the contacting surfaces is, no doubt, molecular. Action is restricted to layers which are at most only a few molecules thick. The factors involved in adhesion are, (1) Components of the film, (2) The nature of the base or substrate, (3) The effects of permeability, elasticity and other properties of 1 and 2, on the conditions at the interface. Constituents of oils, paints and lacquers contain polar molecules. These possess a definite turning force and take definite positions. Molecules containing (OH) and (COOH) radicals are strongly attracted to the surface and act as anchors. Coatings vary widely in adhesion. Oil paints are good. Synthetic resins are good. Alkyd resins are good. Some phenolic resins are poor. Chlorinated rubber is weakly adherent particularly to the light metals. This can be overcome by using a polyvinyl acetate primer. Additional components provide more "anchors" and also help to resist contractile forces as the solvents evaporate. The surface structures of the base metals control the adhesion offered. Lead, magnesium, zinc, light alloys, etc. are difficult to lacquer unless penetrated. Improved adhesion to metals is obtained by (a) chemical treatment of the surface such as phosphating, (b) cleaning and roughening the surface through etching. Permeability to water is a factor involved. Low permeability and low absorptive power are desirable. Elasticity and interfacial stresses are also involved. Adhesion can be evaluated by scratch hardness tests, more practically by use of a razor blade or pen knife.

Synthetic Resin Analysis. Dr. H. Wagner and Dr. H. Schirmer. Paint Manufacture. August 1939. Condensed from "Lacquer Testing." A series of practical tests for determining the resins that go into lacquers and paints, involving physical and chemical differences.

Evaluation of nitrocellulose lacquer solvents. V. W. Ware and W. O. Teeters. Industrial and Engineering Chemistry. September 1939. Continued from August issue, p. 1118. Data obtained by the constant viscosity method for nitro-cellulose solvent evaluation are presented for 8 solvent mixtures throughout the complete range of toluene dilution. The writers demonstrate that normal butyl acetate and iso butyl acetate are alike in solvent powers and ethyl propionate is a good solvent. Charts and graphs are given.

The Aeration Test for the comparison of Thinners by D. D. Rubek. Drugs, Oils and Paints, July 1939, p. 236. By aeration resistance is meant the ability to withstand "bodying" or precipitation. Samples of the thinners are placed in open containers of the same size and shape and are stirred simultaneously with a multiple stirrer. A high speed fan blows a stream of air across the samples. Care must be taken to blow about the same volume of air over each sample. At intervals the stirring is halted and the samples are examined for viscosity increase. After viscosity testing, the volatiles lost are replaced and the stirring continued. Any tendency for "seediness" or precipitation can be noted by pouring the samples on glass plates and examining them by looking through the film. In lacquers and paints, premature thickening results in less coverage per gallon. Illustrations of the apparatus are given as well as typical test results for a series of petroleum thinners.

Covering Power Determination. A. Davidsohn, Paint Manufacture. August 1939. One of the most important tests for paints and lacquers is covering power. No standard measurement for this has been found. One must distinguish between scientific, accurate measurement and practical shop tests. The ability of a paint to cover or hide a surface is determined by the light refractive power of the pigment and the medium in which it is enveloped. It increases with decreasing particle size so that the smaller the particles of pigment, the

ber the covering power. Covering power is defined as "the ability of a pigment when applied by a brush in the form of a brushable paint to a black and white surface to impart to that surface a uniformly white appearance." Various methods for testing covering power, based on this definition, are described, including a method of the author's.

Permeability to moisture of organic surface coatings. H. F. Payne. Industrial and Engineering Chemistry, Analytical Ed, August 15, 1939. Describes and illustrates a method for determining permeability of organic surface films by the use of fiber glass. Gives figures on several tests.

Electric heating units supply heat for air conditioning spray room. Industrial Heating, August 1939, p. 727. The North American Aviation Co. of Los Angeles, California has found that electric heating units solve the problem of warming air for the air conditioner used in their paint spray room. Air is delivered at 49,000 cubic feet per minute, at a temperature of 70° F. The air is heated by a bank of General Electric Oven Type Heaters having a total capacity of 250 Kilowatts. Automatic control of temperature and humidity is constantly maintained.

+ + +

Solvents in Industry

Isopropyl alcohol

(Isopropanol, secondary propyl alcohol, Per-spirit Petrohol, Avantine)

Each month a solvent available to the organic finishing industry will be described. This month *isopropyl alcohol*, which is finding increased use in industry, will be discussed.

Physical Properties

Isopropyl alcohol is a water-white stable liquid with an odor similar to that of ethyl (grain) alcohol. It is in so many respects similar to ethyl alcohol that it has found extensive use both with ethyl alcohol and a substitute for the same, with the exception, of course, of internal usage.

The evaporation rate of isopropyl alcohol is very slightly less than that of ethyl alcohol and considerably faster than butyl alcohol.

Chemical Properties

Isopropyl alcohol is oxidized principally to acetone by potassium dichromate and sulphuric acid. It has been oxidized catalytically with air using metal catalysts, such as silver and nickel. Isopropyl sulphates can be made by mixing the alcohol with strong sulphuric acid while cooling to ice temperature. If the reaction products with sulphuric acid are warmed, isopropyl ether can be obtained. The alcohol acts vigorously with halogens, such as chlorine, bromine and iodine.

Specifications and Properties

	Grade	91%	99%
(1)	Acidity (Maximum) as acetic acid	0.002%	0.002%
(2)	Color	Water White	Water White
(3)	Dilution with water	Infinite	Infinite
(4)	Distillation—Not below	79.5°C.	80.5°C.
	Not over	80.7°C.	82.5°C.
(5)	Dryness (19 parts naphtha)	Cloud	Clear
(6)	Evaporation Rate @ 35°C.		
	5% Evap.	2-4 Min.	2-4 Min.
	25% "	10-15 "	10-15 "
	50% "	20-25 "	20-25 "
	75% "	35-40 "	35-40 "
	90% "	45-50 "	40-45 "
	95% "	50-55 "	45-50 "
	100% "	55-60 "	50-55 "
(7)	Odor	Mild	Mild
(8)	Purity (Not less than) % Vol.	91%	99.0%
(9)	Residue (mg/100 c.c. Maximum)	1.0	1.0
(10)	Specific Gravity @ 20/20°C.	.8175-.8190	.7863-.790
(11)	Weight per gallon, 20°C. (lbs.)	6.812	6.561

SHIPPING INFORMATION

Available in: — Tank Car — 6,000 or 8,000-gallon cars
Tank Wagon — Up to 2,000 gallons
Drums — 55-Gallon Capacity
Cans — One and Five-Gallon capacity

Flash Point — 91% — 63°F · 99% — 59°F.
Fire Hazard — Inflammable
Government Regulations — None
Shipping Regulations — Requires red caution label.

Physiological Properties

Isopropyl alcohol is a complete substitute for ethyl alcohol as a disinfectant and is recommended in 50% strength for use on dry hands and 70% to 80% on moist hands. The alcohol inhibits and stops the growth of bacteria and yeast at lower strengths than are necessary with ethyl alcohol. Isopropyl alcohol is not recommended for internal use. When taken internally, neither exhileration nor incoordination are noted, although headaches may be produced. Acetone may be found in the exhaled breath of humans shortly after consumption of isopropyl alcohol.

Uses

Cleaning Preparations

The alcohol may be used alone or anhydrous in combination with carbon tetrachloride, as a spotting fluid or type cleaner. Because of its solvent power for gums and waxes, it is employed to remove soldering flux, and the absence of denaturants makes it desirable for the removal of facial makeup. It is a good solvent for use in preparing liquid and transparent bar soaps. The following suggested formula provides a good window cleaner:

Isopropyl alcohol	35 gallons
Water	65 gallons
Eosin Dye	4 grams

A different dye may be substituted and perfume added, if desired.

The absence of denaturants which would leave a residue on evaporation gives isopropyl alcohol desirable properties for use in cleaning leather upholstery and furniture.

Dehydrating Agent

In preparing nitrocellulose for export shipment, isopropyl alcohol will be found useful as it escapes the excise tax usually levied on ethyl alcohol. It is a convenient agent for drying photographic films and prints, precipitates, and metallurgical and histological specimens.

Miscellaneous

It is used as a dye solvent, for recrystallization, and for precipitation of such things as Irish moss, pepsin, sugars and starches.

Isopropyl alcohol has a high solvent power for the wax in shellac, and finds application in the preparation of gasket cements and binders. It is also recommended as a vehicle for gum karaya in the manufacture of permanent wave preparations and in making karaya spirit solutions of gum mastic and sandarac. Isopropyl alcohol has found wide use in insecticides, hydraulic fluids, anti-freeze solutions, antiseptics and perfumes.

Acknowledgement is hereby made gratefully to Standard Alcohol Co., and Carbide & Carbon Chemicals Corp., for supplying most of the data used in this article.

NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

New Coating

V. J. Dolan & Co., 1830 N. Laramie Ave., Chicago, Ill., have announced a new coating called "Tops", which is stated to give the equivalent of two coats of lacquer with a single application.

The material air-dries like lacquer and does not require heating or baking or any special equipment. It is said to be tough as lacquer, flows perfectly and rubs easily to a brilliant finish, and is very resistant to alcohol and water.

It is claimed that the coverage is from 30 to 50 per cent greater than with ordinary lacquers. The manufacturers state that because of its unusual properties, they are offering it with certain restrictions. Promiscuous samples will not be sent and the right is reserved in making shipments to such firms that will permit a representative to call for demonstration.

Further details and information can be secured by writing to V. J. Dolan & Company.

Spray Booth Coating

Harris Soap Co., Buffalo, N. Y., have introduced a new spray booth coating called Boothcote, which is stated, to make the removal of waste spray paint possible in the easy manner illustrated in the photograph.

The compound is used on the clean booth using any standard spray gun, and after waste paint has accumulated, it is stripped off in large sheets as shown.

Illustrating removal of waste spray paint in sheets.

Boothcote is reported to be non-toxic, harmless to the skin and to remain effective for months after application. It can also be applied on fan blades and in flues.

The use of this material is claimed to save considerable time over the older methods, such as the use of grease and paper.

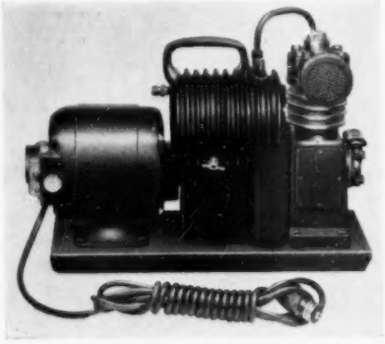
Direct Drive Spray Painting Outfit

DeVilbiss Co., Toledo, Ohio is marketing a new direct drive spray painting outfit known as Type NCK. This electric spray painting outfit is operated by a one-third H.P. motor, having ample capacity, and is a compact and sturdy unit, according to the manufacturers.

Of the piston type, the compressor is directly connected with the motor, has a displacement of 4.58 C.F.M.; holds the Type GC spray gun at 38½ pounds and is said to have no weak or fragile parts, due to modern design.

Mounted on a rubber-footed metal base, the compressor is a single cylinder, ball-bearing type with 2" bore and 1½" stroke. Its maximum working pressure is 40 pounds.

Fan type counter-balanced flywheel reduces vibration to a minimum and assures proper cooling. The finned air chamber relieves pulsation and serves as an oil and moisture separator. The unit is provided with a safety valve, drain valve and connection for hose. Twelve foot length of electric cord with attachment plug and switch at



Direct-drive spray painting outfit.

motor contributes to convenient operation from a light socket.

Supplied with three different assemblies of spray equipment, selection is easily made of the outfit best suited to any type of med ium or small painting or finishing.

Portable Degreasers

Phillips Manufacturing Co., 350 W. Huron St., Chicago, Ill., have announced the manufacture and sale of a line of portable degreasers.

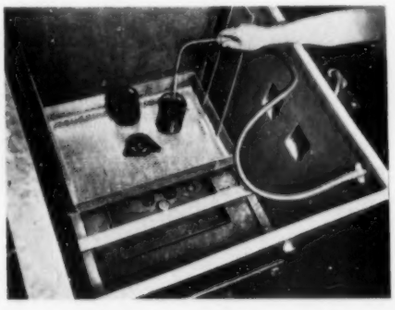
These degreasers are plugged into an electrical outlet and are said to be ready for degreasing in a few minutes. The degreasing is accomplished by the condensing of hot vapors, and with this machine the manufacturers state that from one to three tons of work can be cleaned with from 1 to 1½ gallons of solvent.

The degreasers are electrically heated and controlled. The portable nature of these degreasers make them adaptable for ready transfer to various jobs throughout the plant.

The solvent used is reclaimed and distilled within each machine and the vapor level is maintained electrically within the tank and thus no water jacket or steam lines are required.

Models are available in various capacities for both 110 and 220 volts AC as well as DC current.

Portable degreasing unit.



Interior view of portable degreasing unit.

Methyl Cellulose

The Dow Chemical Co., Midland, Mich., announce the sale of methyl cellulose, which is stated to be a highly versatile, water-soluble cellulose ether.

This ether is recommended to manufacturers of paper, textiles, cosmetics, water paints and grease-proof coatings. It is claimed to be an excellent dispersing, binding, emulsifying, thickening, and sizing material.

Methyl cellulose is completely inert, non-toxic, and non-poisonous, and is not subject to bacterial or fungicidal attacks.

A limited production is now available on four viscosity grades; low, medium, high and extra high.

Steam Vapor Spray Cleaner

Two new models of "Hypressure Jenny" steam vapor spray cleaners, have been put into production by the Homestead Valve Manufacturing Company, Coraopolis, Pa.

These instruments may be either stationary or portable, and develop pressures up to 150 lb. within 1½ minutes. One or two can units are available.

The heating is accomplished by a pressure atomizing fuel oil burner and heating coils.

Steam vapor spray cleaner.

The equipment is recommended for a wide variety of cleaning problems, such as for machinery, floors, walls, automobile engines, large equipment, etc. It is also recommended for stripping paint.

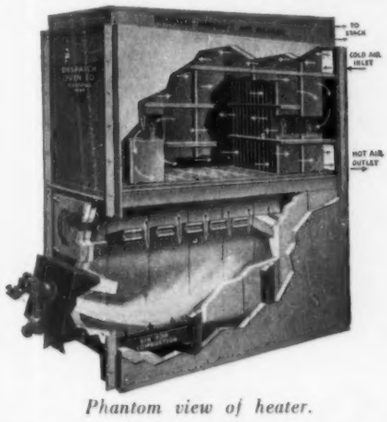
Further information and literature can be obtained by writing to the Homestead Valve Manufacturing Company.

Indirect Air Heater

The Despatch Oven Co., Minneapolis, Minn., have officially announced the development of their new indirect air heater, gas and oil heated, which is recommended for ovens, dryers and space heating.

Briefly, the Despatch indirect air heater incorporates many new features which are said to practically eliminate the maintenance and the replacement of parts that have been necessary on previous heaters of this type which have been on the market for about 20 years.

One feature is the new arrangement of the heat exchanger. It is arranged with a heavy duty alloy cast protecting plate that shields the tubes in the heat exchanger from the radiant heat of the combustion chamber. This added protection feature in the air heaters assists in preventing burned out



Phantom view of heater.

tubes which are very expensive to replace and which cause costly shut downs in the production line when repairs are being made.

The heat exchanger consists of 88 individual tubes which increase the normal area for radiation. Tubes are staggered to produce the greatest possible wiping action of the air as it passes through the heat exchanger. Resistance to air passage through the exchanger is very low.

Another feature is that only one burner is used to obtain 500,000 B.T.U. rating. This is 50% to 75% less number of burners than are required on available indirect air heaters of the same B.T.U. rating. Of course, the smaller number of burners per installation reduces maintenance costs, and the possibility of becoming out of adjustment.

The burner equipment used is a low pressure proportioning type, which keeps a constant ratio between the air and the fuel being used, whether gas or oil. The perfect proportioning promotes, it is reported, high efficiency of operation but most important, eliminates soot and dirt which reduce maintenance of cleaning heat exchanger tubes to an absolute minimum.

EGYPTIAN HIGH-BAKE N. F. R.

A finish which possesses many characteristics, any one of which would classify most finishing materials as a good product. For instance—

1. **A multi-coat finish baked in one operation. Primers and undercoats which air dry yet bake as a composite finish when used with Egyptian High-Bake N.F.R.**
2. **A clear High-Bake N.F.R. for use on rare metals and plated pieces as a protection against scratching, tarnishing, etc.**
3. **Chemical resistance.**
4. **Rust inhibitive properties when used as a complete finishing system.**

These and many other advantages of Egyptian High-Bake N.F.R. make it one of the outstanding products in the field of finishing. Write for further information and recommendations regarding its use for your own particular requirements.

EGYPTIAN FINISHES

THE EGYPTIAN LACQUER MFG. COMPANY
ROCKEFELLER CENTER, NEW YORK

New Dispensing Faucets

Faster flow and quicker shut-off without dripping are two of the important advantages claimed for the new Imperial "Molygate" faucet recently announced by The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago, Ill.

The faucet is of an entirely new type and is designed especially for use in dispensing lubricating oil, paints, varnishes, glue, vegetable oils, molasses and other viscous fluids from barrels and drums. The name "Molygate" was given to the dispenser because of its use for many of the same purposes as molasses gate faucets.

New dispensing faucet.

As an example of the fast flow of this faucet it is stated that the standard ¾" size flows 2 quarts of SAE 50 oil at 78° F. in 9-3/5 seconds under a 2 ft. head.

Dispenser is operated by simply pushing down on the handle and is self-closing. The moment operator releases the handle, a stainless steel spring causes it to "click closed" and the liquid flow stops immediately without dripping. This protection against dripping has been secured by locating the shut-off valve right at the end of the nozzle.

An outstanding feature of this faucet is its neoprene seat vulcanized right into the valve head. Dispenser can be locked open or closed and has a special lug for sealing to sealed drums.

It is made in 2 sizes, ¾" I.P.T. for standard steel drums and 1" I.P.T. for oil companies' sealed drums. Available in bronze or nickel finish.

New Spray Gun

A spray gun designed to serve the needs of industrial decorative work has been developed by the DeVilbiss Company, Toledo, Ohio.

This gun can be used from the drawing of a fine pencil line to the laying of a broad soft spray and is claimed to bridge the gap between a large artist's air brush and the small production or touch-up spray gun.

It is especially recommended for delicate tinting, shading, blending and high-lighting. It is stated to be especially good for fine touch-up on automobiles, furniture and appliances, and its low air consumption adapts it well to the service departments of distributors and dealers where there is a small or limited volume of compressed air available.

Spray gun for industrial decorative work.

Strongly built, this new spray gun is at the same time light in weight. It fits the hand easily, permitting the forefinger to rest naturally upon the trigger of the gun to effect ready control.

Available in a choice of three nozzle combinations, which are adjustable for either round or fan spray applications, the gun offers a maximum spray width of three inches. Control of both width and density of spray is said to be accurate and simple.

ENTHONE

BAKED ENAMEL STRIPPER

Baked enamels removed swiftly and cleanly. No smut —no pigment deposits to wipe off.

Economical—Use 3 parts water—1 part stripper. Enthone Stripper is not consumed during stripping and drag-out is only loss.

Non-Corrosive—No attack on aluminum, magnesium, zinc or other metals.

Glyptal, urea-formaldehyde, resyl, bakelite, and other baked enamels often stripped in less than a minute.

Write today for a sample and information for cutting your enamel stripping costs.

The ENTHONE Co. Chemical Products

NEW HAVEN, CONN.

Manufacturers' Literature

Acid Resistant Paints. A four page catalog section on the line of "Acidseal" paints, derived from rubber by a process which has been developed and patented by the B. F. Goodrich Co., Akron, Ohio. The catalog describes these paints as having unusual properties as protective covering not only for plants and much of their machinery, particularly around pickling and plating operations, but for products which have to be protected from corrosion while in use.

Cadmium and Zinc Treatment. Bulletin No. 7-2-3 describing "Lithoform", which claims to make paint adhere to galvanized iron and other zinc or cadmium surfaces, has been issued by American Chemical Paint Co., Ambler, Pa.

Finishing Catalog and Data Book. Catalog No. 75, consisting of 104 factual and illustrated pages, containing answers to everyday finishing problems, reporting new developments in spray painting equipment, prices, and providing engineering and performance data on all types of spray guns, spray booths, air compressors, painting outfits, etc., has been published by Binks Mfg. Co., 3114 Carroll Ave., Chicago, Ill. This catalog will be sent free to parties requesting it upon company letterhead.

Metal Preparation. A folder on "Metalprep" which is said to remove rust. Other products featured are: "Solderprep" soldering flux; "De Waxit" grease remover; phosphoric acid; "Metalprep" brushes and "Neutroil" anti-rust oils. Neilson Chemical Co., Detroit, Mich.

Organic Finishing Equipment. This catalog containing 44 pages, covers in condensed form, complete spray-painting equipment for exterior and interior painting, automobile refinishing, and equipment for automotive service as well as air and fluid hose and other DeVilbiss specialties. DeVilbiss Co., Toledo, Ohio.

Spraying Equipment. A 23-page catalog describing and illustrating spray painting with Saylor-Beall guns and equipment. Information is also given on the company's filters, regulators, gages, material pressure tanks, valves, fittings, fans, spray booths and compressors. Saylor-Beall Mfg. Co., Detroit, Mich.

Wood Bleach. A folder giving a description of "Blanchit", a wood bleach consisting of two solutions No. 1 and No. 2, which claims to bring out the hidden beauty of the wood grain patterns in "lighter than natural colors." L. R. Van Allen & Co., Chicago, Ill.

FOR ALL PLATING BATHS

DULAC RACK ENAMELS

YOU can now insulate all plating racks yourself with Dulac Rack Enamels . . . easily applied, cost little per rack, provide thoroughly effective insulation.

The Dulac line now includes rack enamels for chrome and other acid baths; rack enamels for cyanide and alkaline baths; and all-purpose rack enamels for automatic plating in either acid or alkaline baths.

No matter what kind of work you are doing, you will find a Dulac Rack Enamel fitted for the job.

Excellent results are secured in rack protection in plating all kinds of metals, especially bright nickel, and chromium.

The enamel is applied by dipping the rack (with contact points protected) and air drying or baking.

The insulation, once applied, is easily kept flexible and in good condition.

Damaged spots are easily repaired.

Used by plating plants of all kinds throughout the country.

The Dulac line also includes Stop-Off Lacquers for sectional and decorative plating, supplied in both air-drying and baking types.

TECHNICAL DATA BULLETIN on DULAC PLATING RACK ENAMELS and STOP-OFF LACQUERS free on request. Gives instructions for use and lists types available. Send for your copy today.

Maas and Waldstein Co. Newark, N. J.

Branch Offices and Warehouses . . . 1658 Carroll Ave., Chicago . . . 1228 W. Pico Blvd., Los Angeles

LACQUERS **PIONEERS IN PROTECTION** ENAMELS

WALKER'S Chlorinated Rubber Finishes stand every TEST – 100 per cent !

This outstanding new finish, developed at the Walker laboratories, is used on metal over a primer. Used with highest satisfaction on metal objects requiring a good durable finish.

Applied by spray, or dipping. Here are a few strong points:

- Has drying qualities of lacquer. — Whether air dried or force dried, the sterling qualities in these finishes are never destroyed.
- Has extreme outdoor durability. Positively resists acids and alkalies.
- Gives a high gloss, or can be modified to a dull finish.
- Is not high priced. We assure prompt deliveries.

Walkers Chlorinated Rubber Finishes can be used to good advantage on your product.
LET US SEND DETAILS AT ONCE

H.V. WALKER CO.

FINISHES TO FIT YOUR PRODUCT

Offices and Plant **ELIZABETH, N. J.**

New England Representatives, BROWN & DEAN CO., Providence, R. I.

The Emblem of Quality in Finishes

DETREX *means* . . . .

ENGINEERED QUALITY in all Cleaning and Finishing Jobs

Whatever your cleaning and handling requirements . . . whether for hand-operated or completely automatic metal cleaning and finishing equipment . . . Detrex Engineers will fit your needs, service your equipment, and give you unbiased recommendations.

Conveyorized 3-dip Detrex Degreaser used for cleaning prior to painting, plating or inspection.

The one complete source for Solvent Degreasers, Stabilized Safety Solvents, Alkali Washers, Compounded Cleaners and Strippers, Bonderite Equipment, Industrial Ovens, Dip Tanks, Wet Spray Booths, and Wet Spray Booth Compounds.

Single-stage, spray-type Detrex Alkali Washer. Baskets of work are carried through machine on roller conveyor.

WRITE FOR DATA OR DEMONSTRATION.

DETROIT REX PRODUCTS COMPANY
13009 Hillview Ave. Detroit, Mich.

Branch Offices in Principal Cities

In the January issue of

ORGANIC FINISHING

you will find the following articles:

Developments of 1939 in ORGANIC FINISHING Materials and Equipment.

Exhaust Booth Designs.

Peeling of Paints.

Modern Rustproofing Methods.

Solvents in the ORGANIC FINISHING Industry.

A Modern ORGANIC FINISHING Dispensing System.

As the last item of "business," *C. C. McLaren*, chairman of the "Whoopee Committee," regaled the membership with motion pictures of the annual picnic at Montebello, which McLaren had taken with his own privately owned movie camera. Thrown on the whitewashed wall of the Hotel Rosslyn dining room, the short reel of film brought gales of delightful laughter, as the various members were shown in posed and unposed situations.

NEW HAVEN BRANCH

The metallurgy class conducted by the Branch got under way Tuesday, October 24th, at the Sterling Chemistry Laboratory, Yale University, with 70 men from all over the State signing for the course.

L. W. Thelin, Chase Metallurgist, reviewed the outline of the course, which will consist of a series of 14 lectures, to be held bi-monthly.

T. H. Chamberlain, Chase Metallurgist, also gave a talk on the "History and Purposes of the Society," and explained details regarding the course.

Shop problems will be discussed after each of the lectures.

Joseph T. Sullivan, Chairman of Educational Committee.

NEWARK BRANCH

Clarence W. Smith, Chief Chemist of Philco Radio and Television Corp., Philadelphia, addressed the Branch on December 1st, the subject of his talk being "Recent Developments in Bright Zinc Plating."

The December 15th meeting will have *George Reuter* of the American Can Co., Newark, N. J., as speaker and a Round Table discussion on plating will take place.

The January 5th meeting will be addressed by *Philip Sievering* of Philip Sievering, Inc., whose subject will be "Electroplating and Its Progress."

Members of the Branch were stunned by the death of Oliver J. Sizelove, and few of the members, therefore, attended the Philadelphia meeting.

NEW YORK BRANCH

Edwin C. Rinker, of Oakite Products, Inc., addressed the Branch on November 10th on "Metal Cleaning Before Electroplating."

The meeting was well attended and a lively discussion took place on the various aspects of the use of wetting agents in cleaning solutions.

The second meeting of the month was a business meeting, followed by a Question Box review conducted by Librarian *Dr. C. B. F. Young*.

F. J. MacStoker, Secretary.

PHILADELPHIA BRANCH

The annual Educational Session and Dance which was held on Saturday, November 18th, was the largest ever held with over 300 members and guests in attendance.

The speakers at the Educational Session were *Dr. L. Weisberg, F. F. Oplinger, Dr. Wm. Blum* and *George B. Hogaboom*.

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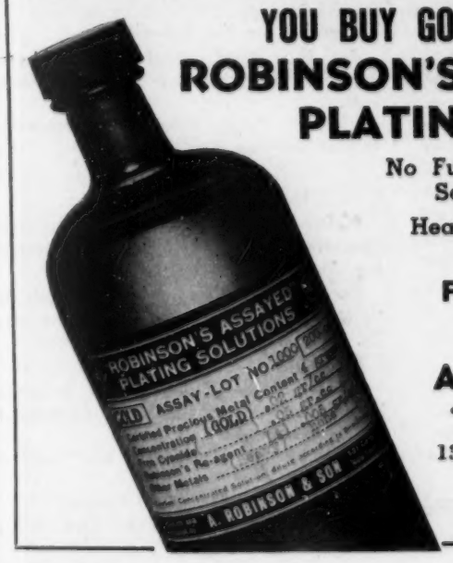

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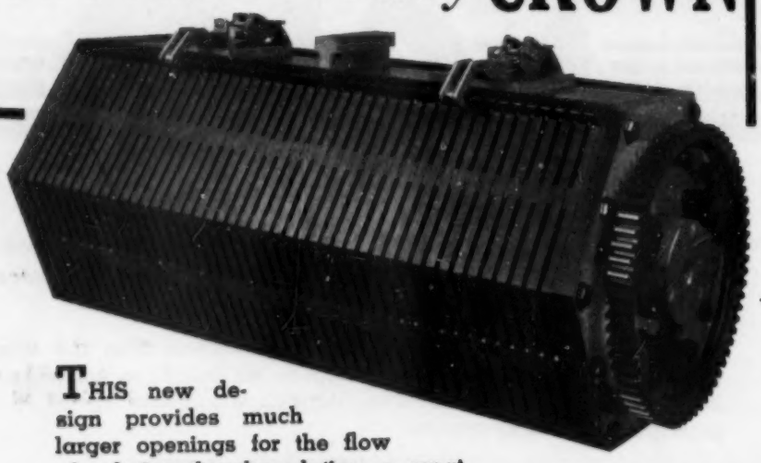

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Inside of barrel is well corrugated for the most effective tumbling action.

Write at once for complete details and prices—no obligation, of course.

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PROVIDENCE-ATTLEBORO BRANCH

On December 18th, the Providence-Attleboro Branch will be given a talk by Dr. C. B. F. Young, technical advisor of A. Robinson & Sons, 131 Canal Street, New York, who will talk on alloy plating as applied to the jewelry trade. The latest developments in this field will be reviewed and Dr. Young will discuss his work on the effects of current density, temperature, agitation and pH on gold, brass and other alloy plating solutions.

Masters' Electroplating Association

A banquet and dance will be held by the Association on Saturday, December 16th at the Hotel Delmonico, 59th Street and Park Ave., New York, at 7 p.m. The program is as follows:

A welcome by *J. J. Forbath*, Chairman, Executive Committee.

Speeches by the following:

Dr. Wm. Blum, Head of the Electrodeposition Div., National Bureau of Standards.

V. W. Todd, President, Hanson-Van Winkle-Munning Co.

J. S. Gildersleeve, President, Golden Gate Mfg. Co.

Walter Plumacher, Past Chairman, Executive Committee, Masters' Electroplating Association.

Entertainment Feature—"Modern Magic" by *George Morrow*, Egyptian Lacquer Mfg. Co.

Dancing.

Master of Ceremonies, *Adolph Bregman*, Executive Secretary, Masters' Electroplating Association.

Music by Otto Bender and his "Fashions in Music."

Song Leader—*Edward McGowan*.

Tickets are priced at $4.00 each.

Electrochemical Society

NEW YORK SECTION

Dr. Samuel Glasstone of Princeton University, addressed the Section on Friday, November 17 on "Aspects of Electrolytic Oxidation."

Dr. Glasstone discussed the theory of hydrogen peroxide formation at the anode as being coincident with oxidation.

Dr. W. R. Meyer, Vice-Chairman, conducted the meeting in the absence of Chairman *Dr. Mueller*.

Personals

H. M. Cherry Joins A. T. Wagner Company

A. T. Wagner Company, 2700 Wight St., Detroit, Mich., have recently announced that *H. M. Cherry* will become manager of metal finishing sales for this company.

Mr. Cherry graduated from the University of Michigan in 1918 with a degree in chemical engineering. After being discharged from army service, he spent one year in the General Motors' Detroit Laboratories, followed by three years with the Harrison Radiator Corporation, Lockport, N. Y., a division of General Motors,

H. M. Cherry

as metallurgist in charge of plating and finishing. He then left this company to engage in sales work for the Rex Products Company, on cleaning compounds.

"Mose," as he is familiarly known, then spent fourteen years with the Hanson-Van Winkle-Munning Company, most of which time was as the Detroit district manager. He left this company to assume his new position with the A. T. Wagner Company.

L. H. Frost is the new district manager in the Detroit area for Thomson-Gibb Electric Welding Company. The Detroit office of the company has been moved to 307 Boulevard Building, from the General

Motors Building. Mr. Frost formerly was chief sales engineer of the a.c. division of Electric Controller and Mfg. Company, Cleveland.

R. B. Nichols has been elected secretary of the Bantam Bearings Corp., South Bend, Ind., subsidiary of the Torrington Company, Torrington, Conn. Mr. Nichols has been associated with the bearing business for the last fifteen years, most of the time with the Bantam Corporation, having held the positions of superintendent and sales manager. In addition to his new duties, he will continue as sales manager.

Clayton P. Innes is the new *Cutler-Hammer* representative in the Company's Omaha territory, according to *C. J. Maloney*, Chicago, Western district manager of the company. Mr. Innes, graduate of South Dakota State College with a degree in electrical engineering, has had many years of field experience in the application of motors and motor control for every type of service.

Wilfred S. McKeon has resigned the presidency of the *Century Fittings Company* of Greensburg, Pa. His resignation was accepted at a meeting of the Board of Directors held at the office of the Company on Tuesday, October 31st.

Our well-known "Liquid Sulphur" Mac seems to be pretty well and favorably known in his own city of Greensburg. He was elected to the presidency of the Fittings Company after the sudden death of the founder and first president of the company, the late *William J. Burkart.*

After getting the affairs of the Fittings Company in order after Mr. Burkart's death, "Wilfred S." came back to his first love—the plating industry—with his entire and undivided attention.

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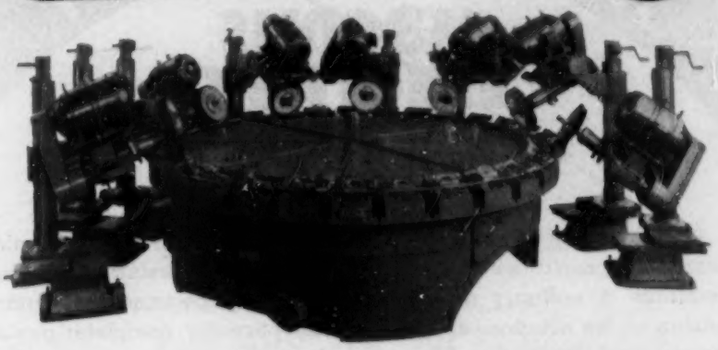
Keynotes to Greater Finishing Profits!



In key plants where automotive hardware such as door handles, trunk hinges, regulator handles, brackets and many other similar parts are measured in hundreds of thousands and more, ACME ROTARY AUTOMATICS, like the one above, rate as "standard practice" machines for high production finishing.

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Learn what an Acme Method and Machine, tuned and timed to meet your finishing demands, has to offer you. Send samples for prompt production estimate . . . no obligation.

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Dr. L. D. Ricketts Elected James Douglas Gold Medallist for 1940

Dr. Louis Davidson Ricketts, consulting engineer, known throughout the world as "Dr. Ricketts of Arizona," was unanimously elected "The James Douglas Gold Medallist for 1940" at a meeting of the Board of Directors of the American Institute of Mining & Metallurgical Engineers, held recently in the Engineering Societies' Building, 29 W. 39th St., New York City. The board voted on the recommendation of the James Douglas Medal Committee consisting of 17 members representing non-ferrous metallurgists from all over the world. The citation proposed by *Stanislaus Skowronski,* research chemist, Raritan Copper Works of the Anaconda Company, Perth Amboy, N. J., Chairman of the Committee, reads: "For Inspirational Leadership and Distinguished Achievements in the Metallurgy of Copper." The medal will be presented to Dr. Ricketts at the annual meeting of the Institute in February 1940.

The Chemical Industry Medal of the Society of Chemical Industry was presented to *Dr. Robert E. Wilson,* president of the Pan American Petroleum & Transport Company, at a joint meeting of the American Section of the Society of Chemical Industry, the New York Section of the American Chemical Society and the New York Section of the American Institute of Chemical Engineers on November 10, 1939, with *Dr. Wallace P. Cohoe* presiding. The medal is awarded annually for valuable application of chemical research to industry.

Perkin Medal Award

Dr. Charles M. A. Stine has been elected to receive the Perkin Medal of the Society of Chemical Industry for 1940. The medal is awarded annually for valuable work in applied chemistry.

The selection is made by a committee representing the five chemical societies in the United States.

Dr. Stine was born in Norwich, Conn., in 1882, and received the A.B., B.S., A.M. and M.S. degrees from Gettysburg College, and then in 1907 he received his Ph.D. from Johns Hopkins University. Since 1907, he has been engaged in organic chemical development with the duPont company, and has risen to the office of vice-president in charge of research. He is also a member of the Executive Committee and Board of Directors of the duPont company.

The medal will be presented on January 12, 1940, at a meeting to be held at the Chemists' Club, 52 E. 41st St., New York City.

NEW HIGH STANDARDS FOR SPEED AND QUALITY

Magnus ELECTREX METAL CLEANERS

This new line of cleaners insures better—faster metal cleaning because of rapid wetting, penetrating and dispersing effects not available in ordinary materials. By greatly lowering the surface tension of the solution, drainage is exceptionally complete; rinsing speedy and thorough. Moreover, drag-over into any succeeding acid dips or plating baths cannot cause trouble or formation of troublesome scums or films. These cleaners are all acid and hard-water-proof.

Particularly effective in electro-cleaning, Electrex Cleaners are also applicable to all metal cleaning operations, with assured improvements in results. There is a grade to meet every need—for die cast and soft metals—for brass—for steel and brass combinations and for steel.

ASK FOR NEW BULLETIN

A bulletin describing this new line of Cleaners is just off the press. Ask for your copy.

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Magnus CLEANERS

Hoosier Lamp & Stamping Co., Oakley and Morgan Sts., Evansville, Ind., metal products, stamped metal goods, etc., has let general contract for a one-story addition. Cost close to $40,000 with equipment. Departments: spinning, stamping, welding, sand blasting, polishing, degreasing, cleaning, plating, tumbling, burnishing, buffing, coloring, anodic treatment, lacquering, enameling and finishing. Aluminum is the principal base metal used.

Joseph B. Kushner, Ch. E., founder of Personalized Plating Service, has moved from 20 Eldridge St., to 192 Broadway, New York. The new quarters were chosen to give increased service to the electroplating and finishing industry.

Verified Business Items

United Chromium, Inc. Win Suit Against Great Lakes Plating Co.

The trial before Judge John P. Barnes of the Federal District Court for the Northern District of Illinois, Eastern Division, of the suit brought by United Chromium, Incorporated against Great Lakes Plating and Japanning Company for infringement of the Fink patents, U. S. Patent Nos. 1,581,188 and 1,802,463, covering methods of commercial chromium plating, was completed on Monday, November 27, 1939. Shortly following the argument, Judge Barnes handed down his decision, holding both patents in suit valid and finding claims 4, 6, 10, 13 and 18 of U. S. Patent No. 1,581,188 and claims 1, 2, 3 and 4 of U. S. Patent No. 1,802,463 infringed.

E. Reed Burns Mfg. Corp. Builds New Plant

The beginning of the present E. Reed Burns organization goes back to the year 1888. In that year, Mr. E. Reed Burns opened on Water Street in Manhattan (under the then new Brooklyn Bridge) a small shop to make Crocus and white finish for the stove trade, to whom he had been selling sheet mica for several years. The business grew rapidly and four years later, he purchased land at 40 to 42 Withers Street, Brooklyn, N. Y. and erected a three-story wooden building, and by this time the products of the new company included all types of buffing compositions as well as polishing wheels and buffs.

The company has expanded until recently a modern two-story brick building containing offices, buffing department, and shipping and receiving department, was built, replacing the building at Withers Street. Also, a one-story modern building has been erected for efficient, straight-line production of polishing compositions at 237-239 Meeker Avenue extension, Brooklyn.

Before Mr. Burns Sr. died in 1928, he saw his three sons become active in the business. These sons carry on the enterprise today; *Russell H. Burns*, president, *Herbert R. Burns*, treasurer and *Lloyd S. Burns*, secretary. Today, the production of the company is centered exclusively on buffing compositions, buffs and polishing wheels.

(Below) Plant of E. Reed Burns Mfg. Corp., Brooklyn, N. Y.

Pennsalt to Build New Philadelphia Plant

After nearly three-quarters of a century on its present site in Philadelphia, the Pennsylvania Salt Manufacturing Company announces that it is moving its Philadelphia plant to a new location more suitable for an expansion program planned for some time, according to statement by *Leonard T. Beale*, President of that company.

In making this statement Mr. Beale said: "The sale recently made of its 62-acre waterfront property at Delaware & Oregon Avenues, said to be the largest real estate transaction in Philadelphia in ten years, is the first step of the Pennsylvania Salt Manufacturing Company in its plans to relocate its Philadelphia plant operations to provide more suitable manufacturing facilities.

"Our Philadelphia plant is one of our manufacturing units extending from coast to coast which produce various heavy chemical products and specialties. For some time we have felt that our Philadelphia property at Delaware and Oregon Avenues was unsuitable for our expansion program. We have therefore decided to relocate our Philadelphia operations on a new site in the metropolitan area where more adequate space and facilities will enable us to produce new products now under development, in addition to continuing the production of certain chemicals now being made at our Philadelphia plant.

"Our Research Laboratory and Pilot Plant operations, which for some years have been badly cramped in the present location, will also be moved to the new site where ample space will be provided for expansion in this important phase of the Company's work. Our executive, accounting, and sales offices will remain as at present at 1000 Widener Building, Philadelphia."

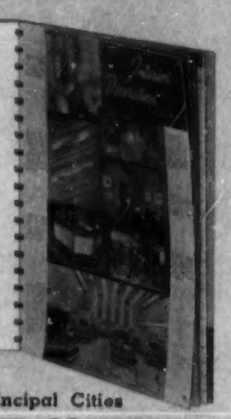
Waukesha Foundry Co., Lincoln Ave., Waukesha, Wisc., brass, bronze, aluminum and other castings, has let general contract for a one-story addition, 80 x 120 ft. Cost close to $60,000 with equipment. The following departments are operated: soldering, brazing, welding, grinding, sand blasting, polishing, cleaning, buffing, coloring, enameling and finishing. Principal base metals used: brass, steel, bronze, nickel silver, zinc, aluminum and lead.

Anderson Chemical Sales Corp., 25-12 31st Ave., Long Island City, N. Y., industrial chemicals, have leased space in the building at 22-14 40th Ave., for a plant, removing their works from the present location and increasing capacity.

I. H. Raber Co., manufacturers of aluminum patterns and bronze, brass and aluminum castings, have moved into a new plant at 5202 Pacific Blvd., Huntington Park, Cal., which contains 6,000 sq. ft. of floor space.

Heidemann Mfg. Company, makers of beauty shop fixtures, have started construction of a new plant, embracing 4,000 sq. ft. of floor space at 327 E. 58th St., Los Angeles, Calif.

STUDIES IN PRE-FINISHED METALS



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"Since installing the Ideal Continuous, wash, rust-proof and dry machine for metal parts, it has saved sufficiently to pay for itself in one year's operation. The work is finished better than with older methods, and at greater speed and considerably lower manufacturing cost."

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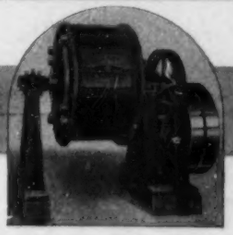

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2 Closes the pores in the metal, increasing resistance to corrosion.

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